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COLON STUDIES

V. THE HIGH CECUM*†

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IT is the object of this study to throw as much light as possible on the form and function of the proximal colon (ceco-colon) by analyzing those cases in which the proximal colonic segment is relatively short or practically absent. For this purpose, obviously, cases of complete congenital non-descent of the cecum would be most desirable. This anomaly, however, is so rare in the complete form that it would be unconvincing—if not actually misleading—to submit our few cases to the broad statistical treatment adopted for the present series of colon studies. Accordingly, it was decided to regard this effort as a rough preliminary communication; and to add to the available cases of complete non-descent those cases in which the cecum, although advanced beyond the subhepatic position, had not progressed below (or much below) the crest of the ilium. To this larger group—the exact criteria for which will be detailed later—we have applied the term "high cecum."

EMBRYOLOGICAL CONSIDERATIONS

In the course of fetal development, the colon undergoes the following progressive changes (Huntington):

1. Migration, during which the primitive intestine leaves the body cavity, enters the hollow umbilical cord, and returns once more to the abdomen. This journey is accomplished soon after the tenth week, and during this period the cecum makes its initial appearance.

2. Rotation, in which the cecum passes counterclockwise from the mid-region at the umbilicus, upward, then from left to right across the duodenum, and, finally reaches the subhepatic position under the right lobe of the liver at about the eighth month of fetal life.

3. Descent, in which the cecum progresses downward from the liver, crosses the crest of the ilium, and comes to rest in the middle of the right iliac fossa. Ordinarily this stage is reached at term, but the development may not be completed for a variable interval after birth.

Although, of course, arrest of development may occur in any of the steps outlined above, the discussion in this paper will be limited to failures in consummating the stage of descent; and it is the result of this failure that constitutes the "high cecum."

This simple description of the high cecum is complicated in some instances by the fact that while the cecum remains fixed in the subhepatic position, the colon just distal to it continues to develop. This

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produces a festoon-like arrangement (see Fig. 6) in which the proximal limb is composed of an inverted "ascending" colon that runs down to a low placed "hepatic" flexure, and then passes on to the ascending limb which rejoins the transverse colon at the level of the liver. This condition is not very uncommon, and may be readily overlooked or misinterpreted in the roentgen examination.

Kelly makes the interesting but unsupported statement that an undescended cecum is frequently associated with an undescended testis (or ovary). None of our male cases presented both these anomalies, although there were 7 cases of undescended testis in our 2,042 patients.

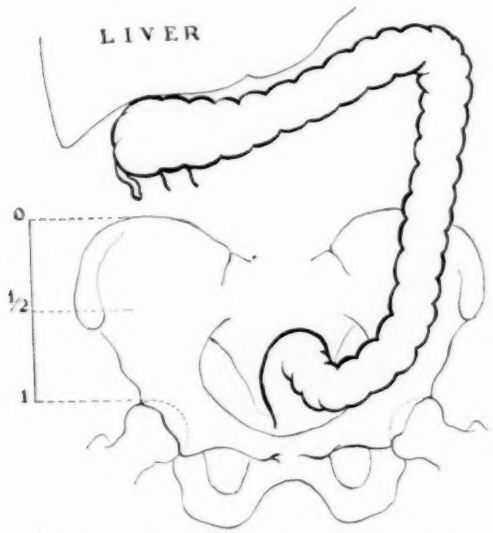

FIG. 1. Diagram of complete non-descent of cecum. Note landmarks: Iliac crest (0); middle of iliac fossa (½); top of acetabulum (1).

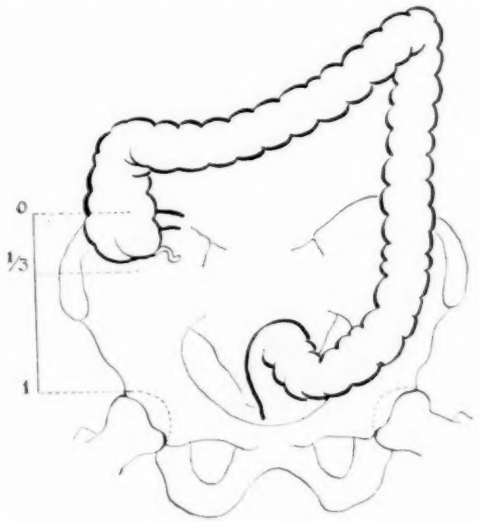

FIG. 2. Diagram of high cecum, partial descent. Note position of cecal tip in upper third of iliac fossa. Lower limit of upper third (⅓). Other landmarks as in Figure 1.

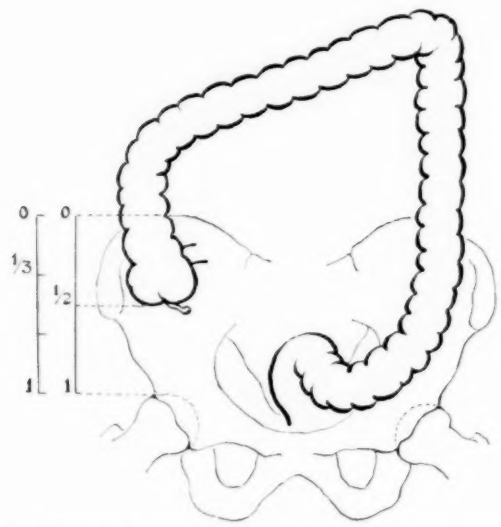

FIG. 3. Diagram of normal cecum. Note position of cecal tip in middle of iliac fossa (½). Other landmarks as in Figures 1 and 2.

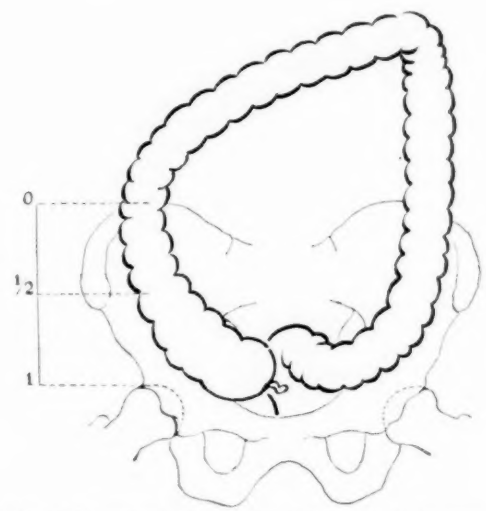

FIG. 4. Diagram of low cecum. Note cecal tip more than half way down in the pelvic basin.

BRIEF SURVEY OF LITERATURE

As might be expected, the first cases of non-descent of the cecum were described

by anatomists, pathologists, and surgeons. In 1882, Lockwood reported a case of high cecum found post mortem. Treves discovered 2 cases of non-descent among 100 autopsies performed prior to 1885. More recent and more important anatomical studies are those of Robinson (1902), Alglave (1907), Smith (1911), Davis (1916), and Harvey (1918).

The surgical literature consists chiefly of scattered case reports of appendicitis occurring in high ceca. Typical papers are

Fig. 5. Complete non-descent of cecum. Cecum in subhepatic position. Film 9 hr. p. c., prone.

those of Lejars (1914), Fowler (1916), Jonas (1921), and Gardner (1921).

The roentgen literature is still meager. Carman mentions the condition in the first edition of his book (1917). Payne and Trahar describe and illustrate 2 cases in their classic study (1921). Faulhaber (1923) quotes Schwarz as having reported a case in detail. The outstanding contribution is that of Jordan who devotes a chapter of his book to the subject, and reports 23 cases (1923). In the past year (1926), O'Hara reported one case, and MacLean three.

MATERIAL, METHODS, TECHNIQUE

This present study is based on 54 cases of high cecum. These were culled from a total of 1,049 roentgen studies on 2,042 office patients complaining of gastrointestinal symptoms. This larger group is the same, brought down to date (July, 1927), as has furnished the material for the previous studies for this series. Practically every one of these patients has had a routine gastrointestinal survey, including a history, physical examination, and test meal.

The best views of the cecum were obtained, as has been previously mentioned, nine hours after the ingestion of the barium meal; but films taken at the other standard intervals (5, 24, 48, etc. hours p.c.), as well as after the opaque enema, were all utilized for study. If a single film of a series failed to meet the criteria imposed, the case was dropped from the high cecum collection. Unfortunately, some

Fig. 6. Complete non-descent of cecum. Cecum fixed in subhepatic position. Festoon arrangement of proximal colon. Film 24 hr. p. c. in prone position; arrow points to cecal tip.

of the most promising cases occurred early in the series before the "nine-hour" observation was incorporated as a routine in our procedure.

In the cases of inverted ascending colon above mentioned (Figs. 6, 9 and 11), in which the proximal colon overlies a retroverted cecum, the right oblique (semilateral) prone position (Figs. 10 and 12), as first recommended by Jordan, proves invaluable in demonstrating the actual condition present.

CRITERIA AND MEASUREMENTS

In selecting our material for this study, we included all cases of complete non-

descent with cecum fixed in the subhepatic position, plus those which fulfilled the following arbitrary criteria (see Figs. 1, 2, 3 and 4):

measured between the crest of the ilium and the top of the acetabulum on the film taken in the usual prone position during slight inspiration.

Fig. 7. High cecum. Partial descent. Film 48 hr. p. c., prone.

Fig. 8. High cecum. Partial descent. Opaque enema.

Fig. 9. High cecum. Partial descent. Cecal tip retroverted, but covered by overlying ascending colon. Film 5 hr. p. c., prone. (See Fig. 10.)

Fig. 10. High cecum. Same case as Figure 9. Retroverted tip revealed by oblique (semi-lateral prone) position. Arrow indicates physiologic direction. Film 5 hr. p. c., oblique.

1. In its highest position in any film of a given case, the tip of the cecum must appear above the iliac crest, at the crest, or in the upper third of the iliac fossa—as

2. In its lowest position in any film of the same given case, the tip of the cecum must lie *within* the upper half of the iliac fossa as above determined. A cecum that extended

half way down or more was excluded from the series.

3. The length of the ceco-colon as measured after the barium meal must not exceed 7 inches (17.5 cm.). This figure was chosen as the *maximum* for high ceca because (as shown in the second study of this series) it represents the average length of the ceco-colon in normally placed ceca. These measurements are all obtained from films taken prone at a distance of 26 or 26½ inches from the tube target.

It may be of interest here to point out that our (roentgen) figures for the length

FIG. 11. High cecum. Same as preceding. Retroverted cecal tip covered by overlying ascending colon. Film 9 hr. p. c., prone.

FIG. 12. High cecum. Same as preceding. Retroverted cecal tip revealed by oblique position. Film 9 hr. p. c., oblique.

FIG. 13. High cecum. Ileal stasis. Colitis. (Note head of fecal column in pelvic colon.) High appendix. Film 9 hr. p. c., prone. C is cecal tip, slightly retroverted; A is appendix; I is ileum showing marked stasis.

FIG. 14. High cecum. Redundant colon. Pelvic loop to right. High appendix. Opaque enema. Arrows indicate physiologic direction.

of the normal ceco-colon in the intact living subject compare reasonably well with those of anatomists, obtained from dead-house material. Thus, Treves considers 8 inches (20 cm.) the normal length, Robinson gives about 7¼ inches (18 cm.), and Jonnesco (quoted in Todd's classic monograph) gives a length for the ascending colon alone which when added to that of the cecum would approximate 7 inches.

Length of Ceco-colon in High Cecum. The average length in our series of 54 cases was slightly over 5 inches (13 cm.). The shortest case measured 2 inches (5 cm.); the longest (of which there were 4) measured 7 inches (17.5 cm.). Comparative figures for normal and low ceca are shown in Table 1. One point must be emphasized strongly

TABLE I

RELATION OF CECO-COLIC LENGTH TO POSITION OF CECUM

	Cases	Average Length
High cecum	54	5+ in. 13.0 cm.
Normal cecum	459	7 in. 17.5 cm.
Low cecum	100	9⅓ in. 23.5 cm.

when working with high cecum material, and that is that the roentgen figures are likely to be particularly misleading as to length in cases of overlying or festooned ascending colon. In fact, Robinson—who has succeeded in burying so much acute observation in defunct and almost inaccessible medical journals—says: "It may be frequently observed that when the cecum is fixed under the liver, the ascending colon measures just as long as if it descended." We are hardly prepared, however, to accept his general conclusion that "non-descent or partial descent of the cecum does not materially lessen the length of the ascending colon."

INCIDENCE

General. The general incidence of high cecum as defined, was found to be 5.1 per cent (54 cases out of 1,049) (see Table II). Of these 54 cases, only 3 could be classed as examples of complete non-descent (Figs. 5 and 6). Ten more ceca were located at or above the iliac crest (Figs. 8, 11 and 13). This gives an incidence of 1.2 per cent (13 out of 1,049) for very high ceca. The remaining cases were, of course, all above the normal mid-iliac level (Figs. 7 and 9).

TABLE II

POSITION OF CECUM IN 1049 CASES
Roentgen Data

	Cases	Per Cent
Non-rotated ceca	2	0.2
High ceca*	54	5.1
Normal ceca	806	76.7
Low ceca	187	17.8
Total	1049	99.8

* In 13 of these cases—1.2 per cent of total number x-rayed—the cecum was at or above the iliac crest.

We have failed to find in the literature any similar (roentgen) figures giving the incidence of high cecum in the intact living subject. It is unfortunate that Jordan limits himself to the statement that he saw 20 cases of undescended cecum in six years of private practice.

The classic post mortem figures for non-descent (complete or partial) may be tabulated as follows:

Treves	2	per cent	in 100	adult autopsies
Robinson	7	per cent	in 435	adult autopsies
Alglave	3	per cent	in 100	adult autopsies
Smith	6	per cent	in 1050	infant autopsies
Davis	1.4	per cent	in 285	adult autopsies
Harvey	2	per cent	in 105	infant autopsies

Harvey, in summarizing the literature, concludes that "in about two per cent of all cases, the cecum may be found in the right hypochondrium, and in about six per cent lying between there and its normal position in the right iliac fossa."

It is generally assumed that the incidence of high cecum decreases somewhat after birth.

Sex. Forty of our 54 cases (74 per cent) were males. This corresponds favorably with the sex incidence as gathered from the literature, which is as follows in terms of the male sex:

Jordan	75 per cent in 20 cases
Robinson (quoted by Harvey)	66 per cent in 30 cases
Alglave	66 per cent in 3 cases
Smith	50 per cent in 63 cases

It is of interest to recall that in low cecum females predominate in possibly greater proportion than do males in high cecum.

Habitus. High cecum occurs much more commonly in sthenics than in intermediates

(almost 4 to 1) and practically never in asthenics (see Table III). The direct opposite is the case in the low cecum.

TABLE III
RELATION OF BODY HABITUS TO HIGH CECUM

	Sthenics		Intermediate		Asthenics	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
2042 unselected cases (general incidence)	476	23.3	1112	54.4	454	22.2
54 high ceca	42	77.7	11	20.3	1	1.8
187 low ceca	17	9.0	67	35.8	103	55.0
In 259 Roentgen-rayed Sthenics						
Low ceca occurred					17	6.5
Normal ceca occurred					201	77.6
High ceca occurred					41	15.7

GENERAL SYMPTOMOLOGY

Although it cannot be said that there is any outstanding clinical syndrome that accompanies the high cecum, it is a striking and significant fact that patients with high cecum offer an almost complete contrast to those with low cecum. The differences in regard to habitus and sex have already been detailed. Furthermore, the possessors of high ceca are larger, heavier, and more vigorous than are those with the opposite cecal posture. The former are more likely to suffer, when once they become patients, with organic digestive diseases, whereas the latter are far more prone to the neuroses and the asthenias.

The marked tendency of low cecum patients to reflex or toxic symptoms (headache, vomiting) is almost absent in high ceca. On the other hand, ileal stasis is considerably more common in the latter. Finally, not only does the incidence of appendicitis vary in the two groups, but the intensity of the disease apparently changes as one group is compared with the other.

RELATION OF THE HIGH CECUM TO VOMITING AND HEADACHE

According to our experience, high cecum patients do not show the peculiar tendency to vomiting and headaches exhibited by those with low ceca. Actually, vomiting occurred with about normal frequency (20 per cent) in high ceca, and over twice as often (50 per cent) in low ceca (see Table IV). The easy "neurotic" vomiting

TABLE IV
RELATION OF VOMITING TO HIGH CECUM

Incidence of Vomiting	Cases	Per Cent
2042 unselected cases (general incidence)	407	19.9
54 high ceca	12	22.2
806 normal ceca	141	17.4
187 low ceca	94	50.0
In 240 Roentgen-rayed Vomiters		
High ceca occurred	12	5.0
Normal ceca occurred	137	56.6
Low ceca occurred	91	37.9

of the low cecum patients was practically absent in the former group, about two-thirds of whom had adequate local causes for emesis in the form of organic conditions at or near the pylorus, such as ulcer, cancer, gall-bladder disease, etc.

If we reverse the inquiry and seek to determine how vomiting patients as such are distributed as to position of the cecum, we find that high cecum vomiters are extremely few in number (5 per cent of the total) and are exceeded more than sevenfold by those with low ceca.

Exactly similar is the situation as to headaches (see Table V), this symptom

TABLE V
RELATION OF HEADACHES TO HIGH CECUM

Incidence of Headaches	Cases	Per Cent
2042 unselected cases (general incidence)	337	16.5
54 high ceca	8	14.8
806 normal ceca	115	14.2
187 low ceca	76	40.6
In 192 Roentgen-rayed Headache Cases		
High ceca occurred	8	4.1
Normal ceca occurred	111	57.8
Low ceca occurred	73	38.0

being three times more common in low cecum patients than in high. Conversely, high cecum headache sufferers are one-ninth as frequent as those with low placed organs.

The explanation for this relative immunity on the part of high cecum individuals to symptoms so common in low cecum carriers must be deferred until we know the exact nature of these so-called reflex or toxic symptoms, and the reason for their high frequency with low cecum. Specula-

tion in this field is attractive, but will have to be reserved for another study.

THE RELATION OF THE HIGH CECUM TO ILEAL STASIS AND COLONIC IRRITABILITY ("COLITIS")

When ileal stasis occurs in high ceca, it offers—owing to the disposition of the parts—a striking and rather impressive phenomenon (Fig. 13). The frequency of this association, however, is still unsettled. Jordan makes the claim that the undescended cecum is constantly associated with serious delay in the lower coils of the ileum. Although at first our figures appeared to point in this direction, we cannot, at the present writing, show that ileal stasis occurs with any greater degree of frequency in high cecum than in normal (see Table VI). On the other hand, ileal stasis in low cecum still appears to be the relatively rare phenomenon originally reported.

TABLE VI
RELATION OF ILEAL STASIS TO HIGH CECUM

Cases with 9 Hour Observation	Ileal Stasis	
	Cases	Per Cent
305 unselected cases (general incidence)	207	52.4
27 high ceca	15	55.5
291 normal ceca	166	57.0
77 low ceca	26	33.7

If now we consider at the same time the incidence of colitis* in regard to the position of the cecum (Table VII), we find that

TABLE VII
RELATION OF COLITIS TO HIGH CECUM

Cases with 9 Hour Observation	Colitis	
	Cases	Per Cent
395 unselected cases (general incidence)	218	55.3
28 high ceca	17	60.7
290 normal ceca	170	58.6
77 low ceca	31	40.2

the same relationship holds as with ileal stasis, namely, colitis is less common in low ceca than in normal or high placed organs. This, we believe, offers further proof of the causal relationship between colitis and ileal stasis. We may therefore conclude that the relatively increased frequency of ileal stasis in high and normal, as compared with low ceca, may be due to the higher irritability of the shorter colons.

Obviously, the whole question needs further study, and final opinions must be suspended until many more data become available.

RELATION OF THE HIGH CECUM TO CONSTIPATION

There seems to be a very definite association between the more common congenital anomalies of the colon and constipation (see Table VIII). Indeed, in a sense, constipation may be regarded as a factor of colonic length, that is, the longer the colon, the greater the tendency to constipation, and vice versa. Thus, whereas only a little over one-third of the high cecum patients are constipated, almost three-quarters of those with redundant colons manifest this disorder.

TABLE VIII
RELATION OF CONSTIPATION TO HIGH CECUM

Incidence of Constipation	Cases	Per Cent
2042 unselected cases (general incidence)	958	42.0
54 high ceca	20	37.0
806 normal ceca	400	49.6
187 low ceca	114	60.9
198 redundant colons	142	71.7

Redundant colon is associated with high cecum in about the usual proportion of cases (approximately 19 per cent, revised figures). An interesting related anomaly is the occasional presence of a right sided pelvic loop (Fig. 14). As might be expected, this variant occurs only in normal and high ceca, but does not seem to be present in low ceca. Its possible existence should be kept in mind, as it has caused considerable annoyance to surgeons as a surprise finding (Curschmann, Shober, Black).

RELATION OF HIGH CECUM TO APPENDECTOMY

A review of our 2,024 histories revealed the fact that 292 patients (14 per cent) had undergone appendectomy prior to our examination. This group of appendecto-

* It may be well to repeat at this point that we use the term "colitis" broadly, and as a short name for a state of increased colonic irritability demonstrable roentgenologically (see studies III and IV).

mized individuals was then divided into "pus" cases and "clean" cases, as established by the history, condition of the scar, operative reports, and other relevant data. Each of these factors was then correlated with the position of the cecum as shown in Table IX.

TABLE IX
RELATION OF APPENDECTOMY TO HIGH CECUM

Position of Cecum	Incidence of Appendectomy		Pus Appendix	
	Cases	Per Cent	Cases	Per Cent
2042 unselected cases (general incidence)	292	14.3	60*	21.7
54 high ceca	8	14.8	5	62.5
806 normal ceca	128	15.8	25	19.5
187 low ceca	43	23.0	7	16.2

* Based on 276 cases.

The results are instructive. In the first place, we have again confirmed our previous finding that low cecum patients are particularly likely to have the appendix removed in the course of their medical vicissitudes. Actually, over one-fifth (23 per cent) of these individuals have undergone the operation. This record is approached by "colitis" patients who run a close second (19 per cent) for the distinction of being the most frequently appendectomized subjects. On the other hand, bearers of high ceca show an incidence of previous appendectomy practically equivalent to that of the average run of patients in our practice (about 14 per cent).

If now we consider the actual operative findings encountered in high and low ceca respectively, we find that the situation is, in a sense, exactly reversed. With all due reservation in regard to the relatively short series of high cecum cases, our figures strongly suggest, if they do not actually prove, that a "pus" appendix is much more likely to be found in the high position than in the low or even in the normally placed organ.

A plausible explanation for this phenomenon we believe to be at hand in the observation of Bryant—unfortunately still not so widely known as we believe it deserves—that appendicitis in sthenic individuals is more likely to run a stormy course than it is in those of slim habitus.

From the surgical point of view, it may be observed that the clinical picture of acute appendicitis in the high position is, in a general way, similar to that of acute cholecystitis. There is usually localized pain and tenderness at the lower rib margin, and a point of tenderness is often, though not invariably (Gardner) present in the right iliac fossa.

SUMMARY

1. The high cecum, as defined in this paper, occurred in 5.1 per cent of 1,049 roentgen-rayed individuals.

2. The high cecum is most frequently encountered in the male sex and in the sthenic habitus.

3. The high cecum is not so frequently associated with certain reflex or toxic symptoms (headache, vomiting) as is the low cecum.

4. Ileal stasis and colonic irritability seem to be closely associated phenomena. The relatively increased incidence of ileal stasis in high and normal, as contrasted with low ceca, may therefore be due to the greater irritability of the shorter colons.

5. Constipation may be regarded as a function of colonic length. It appears to be least common in high ceca, most common in redundant colons.

6. Appendectomy, in general, is performed most often in low, least often in high ceca. On the other hand, a pus condition of the appendix is found most commonly in high, and least often in low ceca.

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ABSTRACT OF DISCUSSION

DR. JAMES T. CASE, Battle Creek, Mich., stated that it is gratifying to have statistics to support our previously accepted beliefs but it is also salutary to have figures which controvert some of our accepted ideas. For instance, the idea that patients with anomalous ceca are likely to have lessened resistance and that high ceca are more prone to suppurative appendicitis. He was not prepared to accept the latter idea until after statistics have given more information. Dr. Case recalled the fact that Dr. Rust, a well-known surgeon in the southwest, had advanced the idea that duodenal ulcer is more prone to occur in the stocky individual than in the asthenic type. His own general observations confirmed that idea. He stated that it had been his opinion that the low cecum was associated with ileal stasis more than the higher placed cecum. Dr. Kantor's statistics seemed to contradict this idea. He raised serious doubt as to the ultimate correctness of these statistical findings because, as Dr. Kantor's tables show, headache and constipation are far more frequent in patients with low ceca and yet ileal stasis not so frequent. He thought that our ideas of colitis or of irritable colon might need to be revised in the light of Dr. Kantor's findings that sthenic individuals are more prone to have irritable colons and that it might even be considered a constant finding in individuals of the sthenic type. He is inclined to think that the report "irritable colon" or "colitis" is made much too frequently.

Questions were asked by Drs. Hunter, Pariseau and LeWald.

DR. KANTOR (closing). Dr. Case makes a good point when he asks how the low incidence of ileal stasis in low ceca can jibe with the increased incidence of headaches and vomiting. Dr. Case assumes that headaches and vomiting are due to something that occurs in the lower ileum. He may be right, but there is another theory that I didn't want to spring at this point, to explain the correlation between the low ceca, and headaches and vomiting. It is, briefly, quite possible that headaches and vomiting may be a function of the upper alimentary tract but below the stomach; that is, the duodenum and the high jejunum, but in this case, particularly the duodenum. You know those experiments of Whipple of Rochester, on the production of a toxic substance very rapidly in a short block of the duodenum. I think the best lead—I have no proof, but only a lead—for the explanation of the nature of headaches and vomiting in low cecum has nothing to do with the position of the cecum and what happens in the cecum and ileum, but has to do with the possibility of a drag on the part of the transverse mesocolon cutting off the duodenum, not giving a complete surgical condition of obstruction, but a functional partial stoppage with reflex symptoms. Dr. Carlson, the physiologist, once told me that if he but touched the duodenum in the experimental animal, he would set off vomiting immediately. In other words, we may be dealing here with a phenomenon secondary to right colon dragging. Indeed, there may be a combination of several favoring anatomical circumstances. You remember that there is early in our fetal development an intimate relation between the

duodenum and the colon; there is a duodenocolic angle. Dr. Huntington used to talk about that at Columbia. I think if we follow that relationship, it may lead to great possibilities. The colon crosses the duodenum in rotation, and it may leave its marks. If there is too much fixation or too little fixation, there may be a drag upon it. Perhaps I have talked too much theory, but hope to have pointed out that it isn't always necessary to assume that the ileum is the responsible factor. There are other possibilities to be kept in mind.

Now as to the idea of colitis being normal to sthenics, I agree with Dr. Case, it would be somewhat revolutionary to say that all sthenics have "colitis;" but it has often occurred to me that it may be normal for them to have a high degree of irritability. That is the way in which I like to use the term "colitis."

As to the question about the point of differentiation between the cecum and the ascending colon, I don't know, except roughly, how to place such a landmark, roentgenologically. There are two ideas that occur. One is the insertion of the ileum. If you can visualize that —which you cannot always do—you have something to go by. The cecum extends from the tip to where the ileum comes in. The other aid is the ceco-colic sphincteric tract. It is rudimentary in man, but is well marked in some animals. Dr. Keith has pointed it out in England, and Dr. Hirsch in this country. I suppose that is a good embryological landmark if you know how to get it, and it is shown clearly enough in some films.

Dr. LeWald is asking me questions that he can better answer. He has the biggest available collection of transposition cases that I can think of, offhand. I have had no comparable experience. In that case where the colon was normal except that the cecum was swung over to the left side, you might say that there was a partial rotation, that the stomach did rotate. Was that fixed over there?

Dr. LeWald. I don't know.

Dr. Kantor. Then we haven't enough data to decide that.

Dr. Pariseau asked some embarrassing questions and I must admit that he is right and that we were just working in the rough. We take the films at 26 and $26\frac{1}{2}$ inches' distance, and when we are measuring them all the same way, the relative length of the low cecum and the high cecum would be all we need for present purposes. We don't make any allowance for the convolution as was shown in the right oblique films. We are just using approximate figures, and we admit the possible source of error.

I didn't answer Dr. Hunter's second question: What change in position of the cecum has occurred as a result of operative intervention, especially on the appendix and gall-bladder? I cannot answer that at all, because I did not pay any attention to that. There may be fixations, and, with adhesions, you would get changes in position; but I don't know of any way of studying them precisely, because the adhesions do not follow any set rules applicable to all cases that I can think of at the moment. Very possibly Dr. Hunter has more data on that than I have.

THE ROENTGEN-RAY DIAGNOSIS OF INFANTILE SCURVY*

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A CAREFUL search has revealed very few articles in recent years in American journals devoted to roentgenology on the roentgen-ray diagnosis of infantile scurvy. With the exception of Newell's[16] report of a case in 1920 none has been found. In the pediatric journals, Pelkan[13] contributed a noteworthy paper on the roentgenographic changes of early scurvy. Simultaneous with the progress made in the knowledge of the etiology of the disease and the therapeutic measures to combat it, advances have been made in the recognition of the early and late changes of scurvy as shown by the roentgen ray. It seems to be an opportune time to correlate the clinical signs and symptoms with the coincident roentgen-ray changes. In spite of the present-day dietary methods of prevention the disease is still prevalent.

Infantile scurvy was first reported as a disease entity by Glisson[1] in 1651. In his treatise on rickets he not only described the symptoms of scurvy but recognized its frequent complication with rickets and properly appreciated the fact that it was not an acute form of rickets. In 1859 Möller[2] described some cases which he termed acute rickets which evidently were scurvy, and he recognized their similarity to adult scurvy. For this reason it is often termed by the Germans the "Moellersche Krankheit." But in 1883 Barlow,[3] basing his opinion on anatomical and pathological studies discovered the similarity of the infantile type to that of the scurvy of adults. He really gave the first comprehensive account of it based on a series of 31 cases. In 1894, 106 cases were reported to the New York Academy of Medicine by various physicians and in 1898 the American Pediatric Society[4] published a very full report of the results of its investigation based on 379 cases. Fraenkel,[5] in 1904 and 1906, described the roentgen-ray appearance of the long bones and drew attention to the "white line." Looser,[6] 1905 and Hart and Lessing,[7] 1913, confirmed the earlier opinion of Glisson and Barlow of the existence of infantile scurvy as a disease entity separate from rickets. Tobler,[8] 1918, gave an account of scurvy occurring in a Viennese foundling institution during the war, in which the children affected ranged from two to fourteen years of age, and so was able to bridge the gap between the infantile and adult types.

CLINICAL MANIFESTATIONS

The disease arises from a defective diet, lacking a necessary vitamine. The greater prevalence of the disease in English speaking countries is supposed to be due to the greater use of proprietary foods in infant feeding. Of these foods, those containing condensed or desiccated milk in connection with farinaceous foods are most frequently the cause. The age of its occurrence is quite constant. Still[9] found that in 64 cases nearly 80 per cent began between the ages of six and ten months. Holt[10] found that four-fifths of his cases occurred between the sixth and fifteenth months. He has, however, seen cases in infants under a month old. Rickets, congenital syphilis and scurvy occur in the order of frequency in the diseases of infancy and childhood.

The clinical picture of the fully developed case of infantile scurvy is not difficult to recognize. There is marked tenderness and loss of movement in the limbs, more often noticeable in the lower extremities. With the tenderness there is associated swelling, and rarely hemorrhagic discoloration of the skin, not limited to the epiphyseal regions but extending upward along the shafts of the long bones. The swelling and loss of movement is often greater in cases showing epiphyseal separations on roentgen-ray examination. At

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times edema may be noted in the swollen areas. Bleeding from the gums may be present but more often only a purplish line of discoloration is seen at the free edge of the gums. The middle portion of the hard palate may sometimes show discoloration and hemorrhage, while orbital hemorrhage is comparatively infrequent. Either macroscopic or microscopic blood is often found in the urine. Bleeding from the mucous membranes is uncommon. A rise in temperature is not unusual. A very high temperature would suggest an associated pyelitis. The association of pyrexia with joint changes has led to an erroneous diagnosis of acute osteomyelitis.

The more insidious symptoms that accompany the early onset of the disease are those which are of especial importance. The early cases resemble the class of cases which Hess[11] has termed subacute infantile scurvy. He believes the symptoms are inconclusive and describes them as follows:

"The patient is usually in the second half year of life, and does not gain in weight or gains very little for weeks. Even if well nourished he is pale and sallow with perhaps edema of the upper eyelids. He is peevish and irritable and the appetite is poor. The gums often show a slight lividity or peri-dental hemorrhage which on a subsequent examination may no longer be visible." Often only a rim of crimson, edging the borders of the upper gum, behind an upper incisor can be seen (Still). The papillae of the tongue may show congestion and a petechial spot may be present on its frenum or on the palpebral conjunctiva, or here and there on the surface of the body where there are erosions, eczema or other skin lesions. The urine may be diminished in quantity but more often is normal or sometimes may contain a trace of albumin or a few red blood cells. The pulse is rapid and becomes markedly rapid and irregular on the slightest movement and excitement. The respirations also are increased in rate. The knee jerks are sometimes exaggerated.

Formerly the diagnosis of this subacute or latent type of scurvy was entirely dependent on its reaction to specific therapy, namely, the feeding of necessary vitamine. Hess thinks that this type is probably the commonest type of the disorder, especially in the larger cities where almost all of the milk supply for infants is pasteurized. He believes it usually passes unrecognized. The feeding of orange juice with a small amount of potato or vegetable before the sixth month, a custom now so prevalent, protects most children, but there is no doubt that a considerable number, especially susceptible, pass through a subacute or latent stage of the disease without recognition. The work of Wimberger,[12] Pelkan[13] and others on the roentgen-ray signs of this stage is most important in that it furnishes another aid beside the therapeutic test for the diagnosis of this type of case.

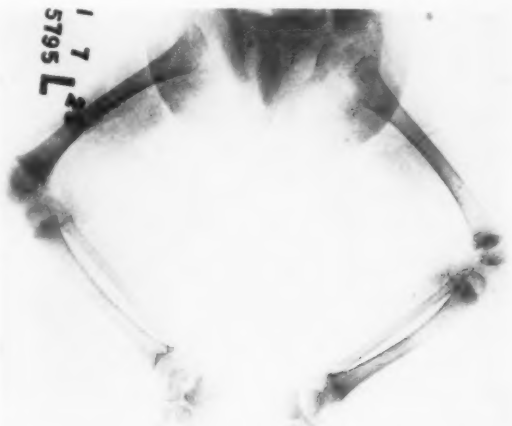

Fig. 1. Illustrates the changes of the first stage: the ground glass appearance of the shaft, the dense zone of temporary calcification at the diaphyseal extremity, the pencil point thinning of the cortex, and the dense ring about the epiphyseal center of ossification with the ground glass appearance of the central portion within the ring.

PATHOLOGY

The most frequent gross pathological lesion of infantile scurvy is the occurrence of subperiosteal hemorrhages. These are most frequently found in the lower extremities and are of much rarer occurrence in the upper. The scapula, ribs, the orbital plate of the frontal bone, and the cranial vault have also been reported as involved (Hess). The hemorrhagic area may extend for a considerable distance along the shaft of the bone. The periosteum is intact at

the diaphyseal ends and so tends to sharply limit the hemorrhage. The blood rapidly coagulates and the process of calcification is also rapid.

With the subperiosteal hemorrhages epiphyseal separations are often found. These are most frequent in the lower extremities. In only one case of this series were separations noted in the the upper extremity, the epiphysis of the head of the humerus, and the distal epiphysis of the ulna. All the others were found in the distal epiphyses of the femur and the tibia. In only one case was an actual fracture of the diaphysis observed and this was very close to the diaphyseal end. Fractures of the middle of the shaft are very common in rickets.

Fig. 2. Illustrates the second stage. In addition to the changes of the first stage, the framework marrow zone can be plainly seen in the lower extremities of the diaphyses of the femurs just behind the dense zones of temporary calcification.

Barlow has pointed out that these lesions should not be regarded as true separations since the line of cleavage is not at the epiphyseal junction but involves the very limit of the diaphyseal extremity and can properly be called fractures or infractions of the diaphysis. They have rarely been so called however.

Hess describes "beading of the ribs" with the formation of a rosary, characteristic of scurvy and entirely independent of the rosary and beading found in rickets. This sometimes leads to an erroneous diagnosis of associated rickets. Microscopic examination of post mortem specimens of cases dying of acute scurvy has proven that this is due to scurvy and not to rickets. No study of the chest was made in any case of this series.

When sectioned the cortex of the long bones is found to be very thin and this is shown on the roentgenogram by the marked atrophy and thinning of the cortex and the widening of the medullary canal. The so-called ground glass atrophy (Pelkan), which will be described later, is caused by the excessive thinning of the trabeculae, and in consequence the latter are often entirely lost on the roentgen-ray negative. At the ends of the long bones where the marrow has usually a deep red color, a yellow marrow is found which has lost its gelatinous consistence. This has been called the "Gerüstmark" or framework marrow (Lehndorf)[14] and is one of the typical lesions of scurvy. At times macroscopic hemorrhages can be seen in the marrow.

MICROSCOPIC PATHOLOGY

In the normal bone, growth in length takes place by the elongation of the diaphysis by means of endochondral ossfication, and growth in width or thickness by endosteal and periosteal ossification, the latter occurring in the so-called cambium layer or the innermost layer of the periosteum (Wimberger).[20] The rate of growth in endochondral ossification is much greater than in periosteal ossification.

The growing bone presents histologically

the following strata or layers from the extremity of the epiphysis to and through the diaphysis. The first layer is the resting cartilage and succeeding this is the layer of proliferating cartilage. Here the intercellular matrix becomes absorbed, the cells become swollen and arranged in free and isolated in the marrow cavity. On these the osteoblasts brought by the blood vessels from the marrow cavity range themselves and the cartilaginous tissue is built up into bone tissue. This is the primary spongiosa or cancellous bone. The thick, ossified trabeculae so

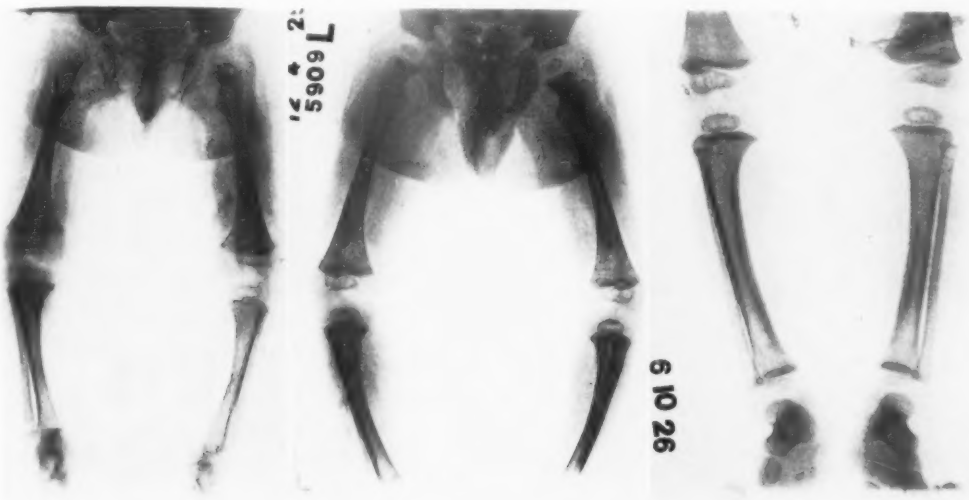

Fig. 3. Fig. 4. Fig. 5.

Figs. 3, 4 and 5. Illustrate a case in the second stage which has progressed into the fourth or healing stage without passing through the third stage of well-developed hemorrhage. Figures 4 and 5 show the characteristic increase in the width of the rings surrounding the epiphyseal centers of ossification with a corresponding decrease in the size of the ground glass central areas. The zones of temporary calcification have become broader and denser.

columns, extending toward the diaphysis, the long axis of the columns lying parallel to the long axis of the bone. In the matrix of the columnar cartilage, nearest to the bone cartilage junction is the site of the preliminary deposition of calcium. This is the zone of preparatory calcification, which, no matter whether it be a flat, convex or concave line, has always a sharp line of demarcation on the roentgenogram. The cartilage cells are regularly arranged in canals containing blood vessels, which infiltrate at regular intervals between the layers of the proliferating cartilage, at right angles to the long axis of the cartilage. Young bone tissue is formed from the preparatory zone of calcification. These blood vessels from the marrow cavity, running parallel and axially from the marrow cavity, break through the groups of the cartilage cells and so form longitudinal islands of ossified cartilage which remain formed are first absorbed by osteoclasts and then constructed afresh by osteoblasts and form the secondary spongiosa which consists of strong trabeculae, the spaces between which are filled with lymphoid marrow.

In scurvy (Pelkan) the proliferating cartilage cells become distorted in appearance and mitosis is lacking. The zone of temporary calcification becomes several times broader than normal and is well calcified, although much distorted. The blood vessels from the marrow cavity are small and few in number and apparently do not enter the cartilage to carry on the normal process of resorption. In the spongiosa immediately behind the preparatory zone calcification is a zone of greatly weakened new bone. Its trabeculae are of poor quality and are no longer covered by osteoblasts. If the latter are present they are of poor staining quality

and are apparently non-functioning. The trabeculae have received no additional calcium. The lymphoid marrow is replaced essentially the same as in the epiphyseo-diaphyseal region. The same broadening of the zone of temporary calcification occurs.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 6. A case in the third stage of well-developed hemorrhage. Lateral spurs can be seen at the lower borders of the right tibia and fibula.

Fig. 7. The same case as in Figure 6 after an interval of three years, showing slight periosteal thickening along the borders of the femur and small rarefied areas of ground glass atrophy still remaining in the centers of the epiphyses. The original dense rings have become broader showing a thin border next to the diaphysis and a thick border next to the joint.

Figs. 8, 9 and 10. Same case as in Figures 6 and 7. The same changes are present after an interval of five years from the onset of the disease.

in this zone by the "Gerüstmark" or framework marrow (Lehndorf).

The changes in the ossifying centers of the epiphyses produced by scurvy are

ROENTGENOLOGICAL CHANGES

These pathological changes produce characteristic changes on the roentgenogram.

1. The broadened zone of temporary

calcification becomes the dense band just at the extremity of the shaft shadow on the roentgenogram. This is usually called the epiphyseal line. If the term metaphysis is used it is the line limiting the end of the metaphysis.

2. Next to this on the side toward the shaft, is the area of greatly weakened new bone which is represented by a zone of decreased density, consisting of the "Gerüstmark" or framework marrow (Lehndorf).

To the first of these changes the term white line has been applied; to the second, the term "Trümmerfeldzone," the latter originating in the German literature. The entire terminology of the roentgen-ray changes of scurvy has been most confusing, especially in reference to these two zones. Wimberger calls the broadened band of temporary calcification the Trümmerfeldzone and the zone of decreased density behind it the white line. Most American writers usually reverse the application of these terms. Fraenkel first called the broadened zone of temporary calcification the white line. Baetjer[15] describes the Trümmerfeldzone as follows: "Just behind the epiphyseal line at a distance of three or four millimeters is what looks like a second epiphyseal line, in reality a band of localized destruction extending through the entire bone and parallel to the epiphyseal line. The edges of this band are denser than the normal bone and give the appearance of eburnated bone, being due probably to the condensation of calcium salts. This band produces an appearance on the plate as if a surgeon had operated and removed a narrow cross section of bone." Newell[16] refers to lines of increased and decreased density and further states that they are often confused.

Pelkan has suggested that the term "scurvy line" be applied to this zone of lessened density for two reasons: (1) because of the confusion that has arisen in the application of the word Trümmerfeldzone to either region, and (2) because the word which literally means zone of "destruction" or "chaos" was applied because of the then prevalent belief that the roentgen-ray changes at the epiphyseal line were due to external trauma. He has shown that these changes are not caused by a traumatic destructive process in the early form of the disease but are due to an orderly pathological process and are present on the roentgenogram in early cases where there is no history or sign of trauma. In the late stages of disease when epiphyseal separations occur trauma is of course a contributory factor.

In the following pages these confusing terms will not be used, and the dense line seen on the roentgenogram at the diaphyseal extremity will be referred to by the term describing the histological change it represents, namely the broadened zone of temporary calcification. The zone of decreased density next to it will be called in the same manner, the framework marrow zone.

Fig. 11. A case of subperiosteal hemorrhages in the humerus and ulna with an epiphyseal separation of the upper epiphysis of the humerus. Third stage.

3. In addition to these two roentgenographic changes, Pelkan describes the atrophy of the cortex of the long bones with the disappearance of the trabeculae in the shaft which causes a curious, smooth, transparent aspect like ground glass. This is found especially well marked near the

Fig. 12. Fig. 13.

Fig. 14. Fig. 15.

Figs. 12, 13, 14 and 15. A case in the third stage showing the broadening of the epiphyseal center of ossification during the fourth or healing stage to cover the calcified hematoma of the shaft thus producing realignment after epiphyseal separation. The formation of transverse striations is also shown. (In Figure 12 the date 9-17-29 should read 9-17-26.)

ends of the shafts. It is not due to the atrophy of disuse since it appears early in scurvy before disability is at all marked and also because the atrophy of disuse is not usually accompanied by the loss of the trabeculation shadows.

4. Wimberger has described a characteristic dense edge about the centers of ossification in the epiphyses of the long bones. This circular edge is produced by the same sort of histologic scorbutic process that is present in the region of the zone of temporary calcification at the epiphyseo-diaphyseal junction. The zone is broadened and the primary spongiosa of the ossification center is weakened. Wimberger reports this change in the astragalus and the os calcis in advanced cases. In the series here studied this change was frequently noted in the tarsal bones, not only in the advanced cases but also in those in the comparatively early stages of the disease.

Wimberger regards this sign as quite constant. Pelkan has confirmed this opinion. Nassa[17] has recently studied this sign together with Fraenkel's sign (the broadened dense zone of temporary calcification at the extremity of the shaft). If the latter was found in both tibiae and at the distal ends of the femora it was called a total sign, if only in the femora or in one of

Fig. 16. Combined rickets and scurvy. There are intact rings about the epiphyseal centers of ossification with evidence of rickets. In addition to clinical signs of rickets this patient had slight exophthalmos, bleeding gums, and pain on movement of the lower extremities.

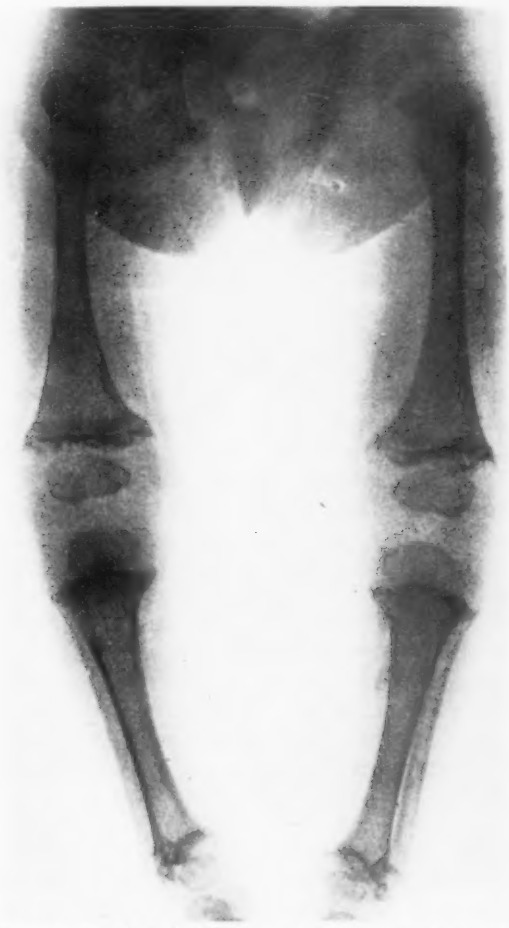

Fig. 17. Combined rickets and scurvy showing intact rings about the epiphyseal centers of ossification with evidence of healing rickets as shown by the formation of secondary zones of temporary calcification in the lower extremities of the diaphyses of the femurs. This patient had a large orbital hemorrhage, marked exophthalmos and pain on movement of the lower extremities. At the lower extremity of the left femur the marginal deposition of calcium along the border of the resting cartilage of the epiphysis according to the calcium protective law of Erdheim is shown.

them a partial sign. Nassa analyzed 15 cases which had infantile scurvy accompanied by rickets and found total signs of the zone of increased density (Fraenkel's) in 5, and partial in 8 cases; in 6 cases he found Wimberger's sign markedly positive, and in 2 cases uncertain, and in 7 clearly negative; and in 2 cases in the same subjects both signs were negative. He also examined control cases of florid rickets, acute poliomyelitis in the phase of stabilization of the paralysis, congenital myxedema and congenital syphilis. He concluded that manifest clinical and roentgenological signs of both rickets and scurvy are necessary to produce Wimberger's sign and that it is not a specific and pathognomonic sign of infantile scurvy but only of infantile scurvy combined with manifest rickets. He also states that Wimberger's sign is found not only in the scorbutus of nursing infants but also in older children, quoting one case of a child of three years and eight months old. The abstract from which this is quoted makes no mention of the fact that this latter case may have shown the broadened ring with small rarefied center which is one of the signs of the healing stage of scurvy to be discussed later. It also does not mention the presence of the ground glass atrophy within the ring which from this study differentiates this sign of scurvy from the atrophy of infantile paralysis and other conditions in which the ring is present, but with it the preservation of the trabeculation shadows within the ring.

In the cases here studied, this sign of the dense edge about the epiphyseal centers of ossification has without doubt been a most constant one. It has not been considered a sign without the presence of ground glass atrophy of the bone of the ossification center within the dense edge or ring. The report of Nassa is lacking in that he studied no cases of scurvy in which there was no manifest rickets. The peculiar preservation of this ring in cases of combined rickets and scurvy will be discussed later under the differential roentgen-ray diagnosis of these two diseases.

5. Combined with the ground glass atrophy of the ends of the shafts is a thin, sharp, almost "pencil point" appearance of the cortex (Pelkan). This is seen also in other types of atrophy and is not solely characteristic of scurvy.

6. In the well-advanced cases small projections (called lateral spurs by Pelkan) can be seen at the diaphyseal extremities which are the first evidence of subperiosteal hemorrhages. Fully developed hemorrhages can easily be seen and the epiphyseal separations are recognized without difficulty.

Based on the analysis of my own series of cases the roentgenographic changes have been divided into four stages. These do not conform to four clinical stages of the disease, inasmuch as it is impossible to divide the process into clinical stages. The first is the most important as it represents the class of cases called by Pelkan the new "borderline case" and that previously described by Hess as the subacute or latent type. Some cases do not progress beyond this first stage other than to show the processes of repair about to be described in the fourth roentgen-ray stage and so do not pass through the second and third stages. Likewise it is possible for cases that have progressed into the second stage to pass into the fourth or healing stage without passing through the stage of well-developed hemorrhage or the third stage. Again cases in the second and third stage may not show all of the signs described as characteristic. Cases in the later stages, however, usually show all or most of the signs of the previous stages.

First Stage. On the roentgenogram the clinical early or latent type of case shows the changes of the first roentgen-ray stage. The most consistent sign is the smooth transparent ground glass appearance of the shaft, especially near the diaphyseal ends. The broadened dense zone of temporary calcification at the very end of the shaft shadow is also present. The cortex shows the pencil point thinning. The sign described by Wimberger, the dense calcified edge or ring about the epiphyseal center of ossification is very constant. The portion of the ring nearest the joint is usually broadened while that nearest the diaphysis is thinner. This is due to the fact that growth is more rapid on the side nearest the joint. The center

shows the same ground glass appearance as the shaft. The clinical recognition of cases in this stage is not always certain.

Second Stage. The second stage is characterized by the appearance on the roentgenogram of the zone of decreased density just behind the dense broadened line or zone of temporary calcification at the end of the diaphyseal shadow. This represents the histologic change, the framework marrow zone. Pelkan believes that the appearance of this zone of decreased density means that the case is well developed clinically and that clinical recognition is always certain. In addition, the first signs of hemorrhage may appear, as evidenced by the formation of the lateral spurs or projections just at the diaphyseal end. This indicates the weakening of the zone of temporary calcification, some of its substance being pushed out by the slight trauma of the distending force of the hemorrhage. Usually all the signs of the first stage appear also in the second. Pelkan believes the presence of the lateral spur usually means the case is clinically far advanced.

Third Stage. The third stage is that of well-developed subperiosteal hemorrhages which usually show the density of beginning calcification within them. The periosteum in childhood is loosely attached to the shaft but at either end of the diaphysis it is firmly attached where it becomes continuous with the capsule of the joint. The hemorrhagic effusions end abruptly at the point of attachment where on the roentgenogram they are sharply limited. It is in this stage that epiphyseal separations most often occur. Occasionally it was noted that separations occurred when only lateral spurs and no fully developed hemorrhages were found, thus placing their occurrence in the late second stage.

Fourth Stage. The fourth stage is the stage of absorption of hemorrhage with repair of all of the scorbutic lesions. Progressive decrease in the breadth and length of the hemorrhages can be seen if frequent studies are made of the patients. But the roentgen-ray signs of hemorrhage as shown by periosteal thickening can persist long after the clinical signs have abated and healing has begun. In Frank's[18] analysis of cases, the earliest disappearance of changes on the roentgenogram was one month, and another showed signs after seventeen and a half months. Newell's[16] case showed the periosteal thickening thirty-six weeks after the onset, and in one of the cases of my series the thickening was present after a lapse of five years. Wimberger[19] has noticed the persistence of signs for three years. It seems possible that in some cases the periosteum may remain permanently thickened.

The calcified hematoma apparently grows with the bone, and the cartilage of the epiphysis broadens to cover the surface of the hematoma. If a separation or dislocation is present, the hematoma will bring the epiphysis again into the center of the long axis of the shaft, and will often itself furnish the greater part of the growth. The zones of temporary calcification become broader and denser. The framework marrow zone gradually disappears and becomes more calcified than the remainder of the shaft. In time the ends of the shafts show double lines of calcification stretching across them. This is due to the fact that as growth proceeds the heavily calcified zone of temporary calcification recedes toward the center of the shaft. It cannot be assumed, however, that such lines when seen necessarily mean that an old scurvy exists. They are believed to be the evidence of any disease process in bone where there has occurred periodic cessation of growth and as such may be the late evidence of myxedema, rickets and other disorders.

Wimberger regards these lines as a measure of growth of the bone during the healing stage, and considers them as pathognomonic of scurvy when at the same time the characteristic epiphyseal changes can be found, namely, the circular ring of increased density surrounding the epiphysis, with its progressive increase in size as healing goes on. The central area of ground glass atrophy shows a corresponding decrease in size. There is no retardation in growth after the healing process has once begun, and he believes there is often an actual stimulation to overgrowth of bone such as occurs in rickets.

He regards the process of repair in the epiphysis as analogous to that in the diaphysis. In the former the concentric ring becomes wider and denser. It preserves the shape previously mentioned, being broader on the side toward the joint and thinner on the diaphyseal side, where often it remains comparatively thin. This is borne out in the study of the cases here reported. Frank describes an anvil-shaped epiphysis but none such was found in my series. The epiphysis resembles a shell of bone consisting of concentric layers with a hollow center. In Figures 9 and 10, the circular zone of calcification is very wide, while the inner zone of the previous ground glass atrophy is very small.

DIFFERENTIAL DIAGNOSIS

The recognition of the roentgenographic signs of the four stages of scurvy should make the differential diagnosis comparatively easy except when a coincident rickets is present. In the early stages, the occurrence of pyrexia, with pain and swelling often confined to only one bone may strongly suggest acute osteomyelitis. In the early stage of the latter no changes are usually present on the roentgenogram, while the early stage of scurvy, on the contrary, shows easily recognizable signs. In the later stages of osteomyelitis, definitely outlined areas of rarefaction, combined often with a periostitis, are shown. Three patients of this series were referred for roentgen-ray examination with a questionable diagnosis of acute osteomyelitis.

Sarcoma can be confused with scurvy only in the third stage or that of well-developed hemorrhage. The sharp limitation of the outlines of the hemorrhagic areas at the diaphyseal ends, together with the absence of any signs of malignant invasion and the presence of the other associated signs of scurvy should confirm the diagnosis. The mistaken diagnoses of sarcoma on record were mostly made before the roentgenologic signs of scurvy, other than hemorrhage, were reported and confirmed. This error should now never be made.

Two manifestations of congenital syphlis, osteochondritis luetica and periostitis luetica might possibly cause difficulty in the differential diagnosis from scurvy. In the former the calcium network shadows near the diaphyseal ends are very irregular and disordered in appearance. The structure of the diaphysis is evenly blurred and does not show any definite resemblance to the ground glass appearance of scurvy. The framework marrow zone of scurvy never shows the calcium network as in syphilis. The calcifying hemorrhages and the periosteal thickening which persist for a long time in the healing stage of scurvy can readily be distinguished from periostitis luetica by the other skeletal changes of scurvy.

A well-developed case of florid rickets, even in the first stages of healing has so characteristic an appearance that no confusion with scurvy is possible. In the passive type of florid rickets, the epiphyseal center of ossification has an irregular outline with no sharp dividing line from the diaphysis. It has a somewhat moth-eaten appearance. There is no dense broadly calcified zone of temporary calcification as in scurvy. Instead fine half calcified trabeculae can be distinctly traced extending out into the resting cartilage of the epiphysis. The spongy and the compact bone show a wide meshed structure instead of the smooth ground glass appearance of scurvy. This type of rickets has been termed passive by Wimberger[30] because the child exhibits a condition of passivity, lying on his back and not moving the extremities. The active form of florid rickets (Wimberger) is found in patients who show both good bodily and mental activity. These show the cupping of the diaphyseal ends in certain bones, namely, the distal ends of the ulna, radius, and tibia, and the proximal and distal ends of the fibula. The distal end of the humerus never shows this cupping even in the most severe cases of rickets. As a part of this cupping there is marginal ossification along the borders of the epiphysis nearest to the diaphysis. This curves outward and either upward or downward, depending on whether the upper or lower extremity of the bone is affected, forming a marginal semi-encircling calcified envelope. This is caused by the fact that bone formation

by osteoblasts is most active at points of the greatest mechanical strain. Erdheim states that long bones in the form of a hollow cylinder suffer the greatest strain at the periphery and since in rickets there is a deficiency in calcium this marginal ossification, to a varying extent, results. The calcium thus selects a position for its deposition according to a mechanical law (calcium protective law of Erdheim).[21] As a result, on the roentgenogram these small projections of calcium might be mistaken for the lateral spurs of scurvy. In the latter, however, the spurs in almost all cases extend at right angles to the diaphysis and have no semicircular form. In this active form the epiphysis does not uniformly have the typical moth-eaten appearance but there is scarcely ever the distinct surrounding edge or ring such as is seen in scurvy. In healing rickets the frayed out diaphyseal end becomes more dense due to the preparatory zone of temporary calcification becoming more calcified and wider. Behind this there is often a zone of uncalcified osteoid tissue, and as a result this may resemble scurvy with its broadened zone of temporary calcification with the framework marrow zone behind it. Cases of scurvy, however, show a disappearance of bony structure with a cortex as thin as a pencil point or paper. In addition, the spongy bone in rickets maintains for a considerable length of time coarse meshed trabeculations while these are entirely absent in scurvy. The broadened zone of temporary calcification in healing scurvy, especially in cases where epiphyseal separations and hemorrhages have occurred, is pushed backward into the diaphysis and for a long time remains as a more or less wide, slightly dense transverse band. In healing rickets the formation of a new zone of temporary calcification a slight distance from the diaphyseal end might simulate this appearance but the above mentioned coarse meshed trabeculations are never present in uncomplicated scurvy.

The combination of changes on the roentgenogram due to coincident rickets and scurvy in the same child is only seldom recognized with certainty. However, when scurvy develops in the healing period of severe or moderately severe rickets, the diagnosis of the combined diseases can be made. This observation made by Wimberger seems to be confirmed in the study of the present series of cases. The intact ring surrounding the epiphysis with the presence of the other unmistakable changes of rickets is the most trustworthy and reliable sign of a coincident scurvy.

Every effort should be made in the examination of the lower extremities to have the knees absolutely extended on the film in the anteroposterior view. Flexion of the knees produces an irregularity of outline of the lower end of the diaphysis of the femur and the upper end of that of the tibia which is likely to be confusing, in deciding whether rickets or scurvy is present. The broadened zone of temporary calcification in scurvy will under these circumstances assume an irregular appearance resembling that of rickets.

ANALYSIS OF CASES

In this series 56 cases were examined from the roentgen-ray laboratory of the Children's Hospital, and checked with the clinical histories. They consisted of 13 cases in the first stage, 33 in the second, 9 in the third and one in the fourth. The latter was a case referred for its first examination with a diagnosis of scurvy and was found to be already in the fourth or healing stage. Whenever possible the patients returned for examination at intervals to note the progress of the healing stage, so that a considerable number were traced into the fourth stage. In the 13 cases of the first stage, a clinical diagnosis of questionable scurvy had been made in 2; 5 cases had been diagnosed as scurvy; 4 were sent for examination with diagnoses other than scurvy, and in 2 cases no record could be found of the diagnosis before roentgen-ray examination. This demonstrates that the clinician should be able to recognize or at least suspect the latent type of case and send them for roentgen examination. Without this co-operation on the part of the clinician only well-developed cases in the second or third stages will find their way to the roentgen-ray laboratory.

Of the 33 cases of the second stage, 9 were diagnosed clinically as questionable

scurvy, and the remaining 24 as scurvy without question. This substantiates Pelkan's statement that the appearance of the framework zone on the roentgenogram means that the disease is well established and the clinical recognition is easy. A great proportion of these cases did not advance to the third stage of well-developed hemorrhage.

In only a small proportion of the cases was the note of clinical improvement on orange juice or its equivalent lacking. In many of the cases the children when first seen had received no orange juice or the statement of the mother was recorded that an attempt was made to feed it but the child refused to take it.

In all cases (irrespective of the stage), the sign of the concentric ring about the epiphysis with the ground glass atrophy of the central portion was noted. This establishes the value of this sign in the diagnosis of scurvy.

SUMMARY AND CONCLUSIONS

The diagnosis of scurvy on the roentgenogram in its well-developed stages is not difficult and the essential roentgenographic signs of these stages have long been recognized. The latent or early type of case is a well-established clinical entity and the characteristic roentgenologic signs of this stage have been described in pediatric literature, but seem to have had little recognition by roentgenologists.

The disease process shows four roentgenographic stages. The first is the most important in that it is possible to diagnose this early stage of the disease on the roentgenogram when the clinical diagnosis is uncertain. The fourth or healing stage may show characteristic signs even though in some cases five years may have passed since the onset of the disease.

The analysis of the cases of this series shows without doubt the value of the sign described by Wimberger, the dense edge or ring about the ossification centers of the epiphyses, when combined with the characteristic ground glass atrophy of their centers. The fact that this ring remains intact in cases of combined scurvy and rickets, while in the case of isolated rickets the epiphysis has a somewhat moth-eaten appearance with no ring shadow, is a most valuable aid in the recognition of scurvy in combination with rickets in the same patient. The analysis further shows that the appearance of the shadow of the framework marrow zone on the roentgenogram means that the case is one of well-developed scurvy and the clinical diagnosis can in almost all instances be made without question (Pelkan).

The fourth or healing stage will show signs on the roentgenogram from one month to five years or more after the onset of symptoms. The transverse striations can be regarded as a measure of the growth of the bone after the onset of the disease. The realignment of the long axis of the bone with the epiphysis after separation had occurred was a constant finding.

The terms of the present nomenclature, white line, scurvy line, Trümmerfeldzone, etc., are used in an indiscriminate fashion, and are very confusing. The terms, broadened zone of preparatory calcification and framework marrow zone typify the histological changes that take place in the course of the disease and when applied to the roentgenographic changes admit of no confusion.

The statement made in textbooks of roentgenology that scurvy does not show any roentgenographic changes in the epiphysis and that in this way scurvy can be distinguished from rickets, cannot now pass unquestioned. This series of cases together with the past work of Wimberger, Pelkan and others shows that such epiphyseal changes do exist.

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ABSTRACT OF DISCUSSION

Dr. H. K. Pancoast, Philadelphia, stated that Dr. Bromer had been unusually fortunate in seeing so many early cases of scurvy. We are all familiar with the manifestations in the late stages but as Dr. Bromer had pointed out the modern methods of feeding children usually bring about a cure in cases of scurvy before they reach a late stage. Dr. Pancoast also emphasized the lack of uniformity in roentgen terminology in this disease. He said that it is particularly important for us to avoid such confusing terms as the "white line," an appearance which is interpreted by one individual in one location and by another in another location. If we avoid such terms as the white line altogether and use scientific terms we shall have a much clearer impression of the disease. He thought that one of the most important things that Dr. Bromer had accomplished was the classification of the stages of the disease and that most important in this classification are the early signs. These early signs can be readily recognized with possibly one exception, that is the ground glass appearance. He had for a time doubted the value of this ground glass appearance because it will always be seen in roentgenograms if there is the slightest movement during exposure. Dr. Bromer had convinced him that the ground glass appearance is a striking and important sign of infantile scurvy.

He also called attention to the presence in these cases of a small lateral spur to which Dr. Bromer had first directed his attention. These cases are often diagnosed as osteomyelitis but when there is present the lateral spur, the so-called Wimberger ring around the epiphysis, the increased density of the broad end of the diaphysis and distal to that a slight atrophy, the picture of scurvy is perfect and there is no reason why the case should be mistaken for osteomyelitis.

Dr. D. R. Bowen, Philadelphia, called attention to the danger of diagnosing cases of scurvy not only as osteomyelitis but also as sarcoma. He also called attention to the fact that scurvy is not always due to deficiency in the amount or variety of food but rather in faulty methods of preparation of food. He cited an instance of twin babies whose food was so carefully sterilized that they both had scurvy. The disease may occur in wealthy families as well as among the poor.

Dr. Bromer, in closing, emphasized the point made by Dr. Bowen that rickets and scurvy are not diseases of poverty. In the matter of differential diagnosis he emphasized the fact that in the early stages of osteomyelitis there will probably be no bone changes at all, while in the early stages of scurvy there are present the Wimberger ring, ground glass appearance and other signs of scurvy. With regard to sarcoma, he thought that the mistake ought never to be made if signs of scurvy other than periosteal hemorrhage are recognized.

THE ROENTGENOLOGIC MANIFESTATIONS OF PRIMARY CARCINOMA OF THE LUNG

II. BRONCHIAL TYPE

BY

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IN the first study[1] we showed that primary carcinoma of the lung could be divided roentgenologically into two types, bronchial and parenchymal, and discussed the roentgenologic diagnosis of the latter. We shall now discuss the bronchial type, of which we have collected 28 cases, all observed at the Mayo Clinic since 1923.

We take as proved bronchial carcinoma those cases in which the lesion was demonstrated at bronchoscopic examination and in which biopsy of the lesion itself showed carcinoma; or alternatively, cases ultimately coming to necropsy in which carcinoma of the lung was found, which appeared to be primary in the bronchus. There are 13 of the former, most of them reasonably early cases, and 5 of the latter. In addition we studied a group of 10 cases in which the diagnosis was not established microscopically but in which all the other evidence pointed to malignant tumor of the bronchus (in a number of these cases the lesion was actually seen through the bronchoscope).

Pathologic examination of the growths showed about equal numbers of epithelioma and adenocarcinoma, most of which were highly malignant.

Clinically the dominant early symptoms were unusually persistent cough and periodic hemoptysis or constantly blood-tinged sputum. Often pain and dyspnea did not appear until late in the disease. As in all cases of carcinoma of the lung loss of weight is a striking symptom.

We have already discussed the literature on this subject fully. All bronchial carcinomas must inevitably fall into the group previously called hilar or infiltrating.

The roentgenograms used in this investigation were taken in ordinary routine roentgenography of the chest. They were stereoscopic views taken directly postero-anteriorly and no special methods of examination or unusual positions were used. We believe that what is needed is to discover whether an appearance or group of appearances may be found in ordinary roentgenograms of the chest which will be sufficiently suggestive of the probable presence of malignant lesions of the bronchus to justify bronchoscopy.

Taking the group of lesions proved bronchoscopically as representative of an early group, can we develop a composite picture of this sort? We believe that we can. The major roentgenologic characteristics of bronchial tumors are two-fold: density in the hilum, and atelectatic or bronchiectatic appearance.

The density in the hilum is the more important. It has always been realized that density of the hilum is the commonest indication of a lesion found in a roentgenogram of the chest, but usually this observation is dismissed with the statement: "indistinguishable from any other enlargement of the hilum," and therefore it is assumed to be undiagnosable. While this is partly true, we believe that the question should not be so easily dismissed.

We admit, however, that we have been disappointed in an attempt to determine the appearance that is peculiar to the type of density in the hilum in bronchial carcinoma, irrespective of the history. It may be simulated by other enlargements of the hilum but it has some particular characters and no lump in the hilum with these characters should be dismissed as not malignant, except in the face of a clear history.

Thickening of the hilum is very common. We examined a large number of roentgeno-

[1] Kirklin, B. R., and Paterson, Ralston. Roentgenologic manifestations of primary carcinoma of the lung. I. Parenchymal type. Am. J. Roentgenol. & Rad. Therapy, Jan., 1928, xix, 20–27.

grams showing such thickening and in from 90 to 95 per cent the density is bilateral. It is an important distinguishing point that in bronchial carcinoma there is density of the hilum on one side and not on the other. Other lesions with this unilaterality are not so common as to make this sign unimportant in the diagnosis of malignant disease of the lung.

The density varies. Figures 1 and 2 show what we would like to consider the typical picture. Figure 3 shows a softer lesion, but none the less a definite unilateral lump. The lesion is roughly triangular, apex out. It has no clear-cut edge but throws out strand-like processes into the lung tissue, along the normal markings of the bronchial tree. When the growth is early, the point of central density tends to be just perceptibly demarcated from the mediastinal margin. As it grows, of course it expands from the hilum, both into lung tissue and medially into the mediastinum thus losing this point of distinction. Even then, however, it remains centered at the hilum.

The site of the density is fairly constant. It lies opposite the space between the sixth and eighth ribs, commonly at the seventh rib posteriorly. In other words, it always occupies the hilum and the whole hilum; should it occur even a short distance away from the hilum it indicates a parenchymal lesion that may easily fail to produce the early symptoms, and which will not be visible on bronchoscopic examination.

Atelectasis, the second characteristic, is not so constant; however, it is of great value in diagnosing those tumors which lie largely within the mediastinum. Two cases, as shown in Figures 4 and 5, are clearly of this type. Figure 4 shows atelectasis of the middle lobe, Figure 5 atelectasis of the upper lobe. In both there is the smooth homogeneous density, anatomically limited and carrying normal lung markings, that is typical of atelectasis. This is not diagnostic of malignancy but it is almost diagnostic of organic bronchostenosis, for which a cause must be sought. Figure 6 is unusual; the appearance suggesting pneumothorax on the left is actually

FIG. 1. Carcinoma of bronchus showing as a density of the hilum. The patient, a man, aged forty-eight, a coal miner, had suffered for two years from gradual loss of weight, chronic non-productive cough and low-grade fever. On bronchoscopic examination at the Clinic an epithelioma of the right bronchus was found. Biopsy showed squamous-cell epithelioma, graded 3. The patient died ten months later from hemorrhage, and the diagnosis was further confirmed at necropsy.

FIG. 2. Carcinoma of bronchus showing as a density of the hilum. The patient was a woman, aged forty-two, who gave a history of cough and hoarseness for six months. On bronchoscopic examination an ulcerated bleeding lesion was found which proved to be adenocarcinoma, graded 1 (an unusually benign type for this situation). The patient improved greatly under radiotherapy.

FIG. 3. Carcinoma of the bronchus evidenced by increased density of the hilum. The patient, a man, aged thirty-nine, had chronic cough, associated with frequent mild hemoptysis, and slight pain in the chest for four months, and had lost 30 pounds. Bronchoscopic examination showed a soft bleeding lesion on the left main bronchus which at biopsy proved to be adenocarcinoma, graded 4.

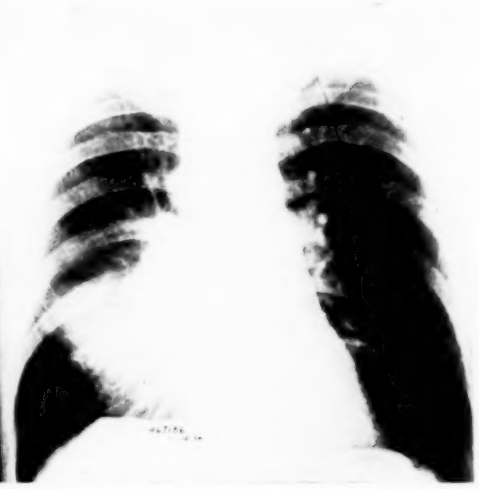

FIG. 4. Atelectasis of the middle lobe due to carcinoma obstructing the bronchus. The patient, a man, aged fifty, gave a history of hemoptysis and severe cough for one month and was examined bronchoscopically. An epithelioma, graded 3, was observed. A large tumor of the bladder had been removed two and a half years previously, and the condition may have been metastatic, but the lesions were microscopically different and the pulmonary lesion was considered as a second primary one.

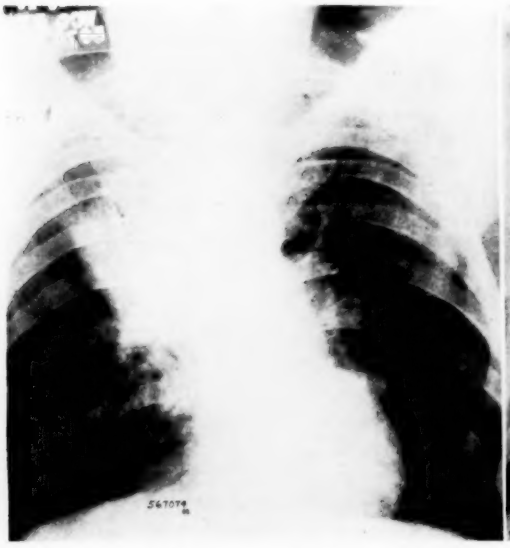

FIG. 5. Atelectasis of the upper lobe due to carcinoma seen on bronchoscopy to be obstructing the right main bronchus at the opening of the upper bronchus. The lesion gave the appearance of epithelioma although biopsy did not confirm this. The patient, a man aged fifty-six, complained of having suffered for eight months from cough and loss of weight. The sputum had been blood-streaked on many occasions. He died three months later.

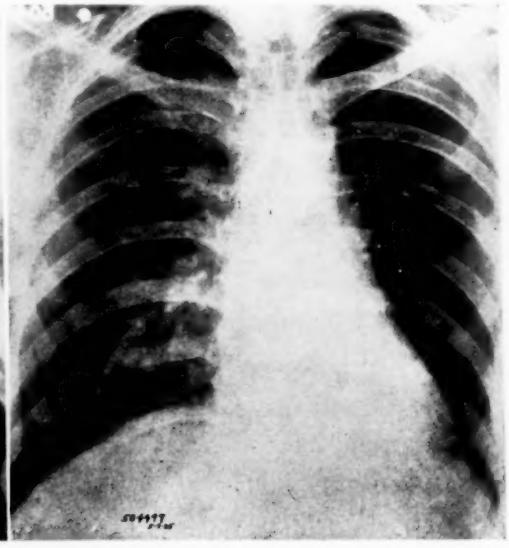

FIG. 6. Complete atelectasis of the lower left lobe due to obstructing carcinoma of the bronchus. The remainder of the lung shows compensatory emphysema. The patient, a man, aged twenty-nine, had had pain in the chest associated with fever, dyspnea and hoarseness for five months. There was no cough or hemoptysis but there was paralysis of the left vocal cord. Bronchoscopic biopsy showed adenocarcinoma, graded 4. Four months later the patient died.

FIG. 7. Total atelectasis of the lung due to obstruction of the main bronchus by a lesion proved on bronchoscopic examination to be a squamous-cell epithelioma, graded 4. The patient, a woman, aged forty-one, had had a productive cough for twelve months and had lost 40 pounds. There were several palpable metastatic nodes in the neck.

FIG. 8. Carcinoma of bronchus with evidence of bronchostenosis shown by collapse of the ribs and elevation of the diaphragm. The patient, a woman aged forty-nine, died from a metastatic brain tumor without any evidence of the pulmonary lesion, which was found at necropsy obstructing the right bronchus and causing total atelectasis of the lower lobe. There was generalized metastasis.

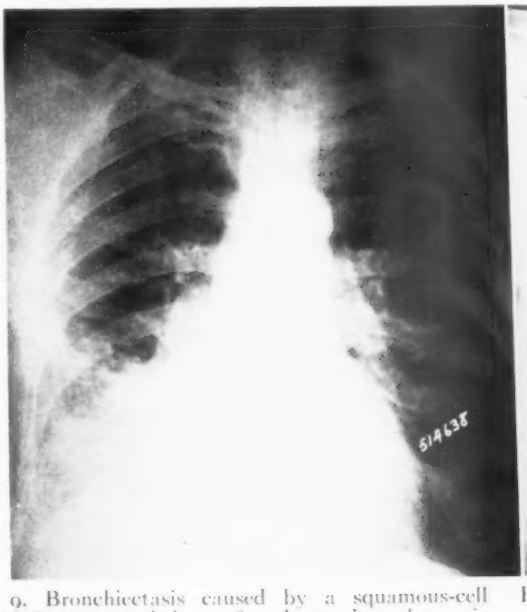

FIG. 9. Bronchiectasis caused by a squamous-cell epithelioma, graded 4, found on bronchoscopic examination in the lower right bronchus. The patient, a man aged fifty-eight, did not recover entirely from an attack of pneumonia which had occurred eight months previously. There had been a gradually progressive infection of the right lower lobe with much cough and sputum. Leucocytes numbered 21,000. Pus pockets were seen at bronchoscopic examination.

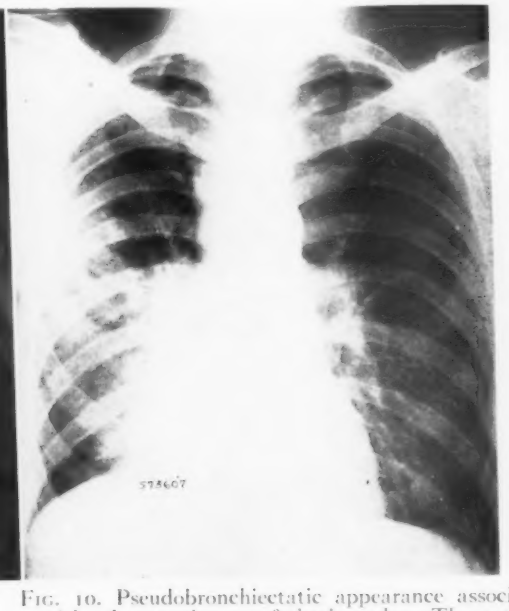

FIG. 10. Pseudobronchiectatic appearance associated with adenocarcinoma of the bronchus. The patient, a man aged thirty-one, had had a cough for four months, and had noticed loss of weight, but there had never been any evidence of an infective condition and no leucocytosis. The lymphatics of the neck and axilla were enlarged. Death occurred three months later.

compensatory emphysema of the whole upper lobe, the lower lobe being totally atelectatic and lying collapsed behind the heart. This condition is indicated by slight collapse of the ribs and by marked displacement of the heart to the left. If the whole lung is involved, there will be associated elevation of the diaphragm, relative collapse of the ribs, and displacement of the heart to the side of the lesion. Such a condition is illustrated in Figure 7, and even more strikingly in Figure 8.

FIG. 11. Mediastinal multiadenopathy arising from a small carcinoma, graded 4, found at necropsy at the bifurcation of the trachea. The patient, a man aged thirty-eight, had suffered for four months from cough and for two weeks before admission to the Clinic from dyspnea and weakness. He died suddenly in a dyspneic attack. Generalized metastasis was found at necropsy.

Bronchiectasis, which sometimes occurs, is evident in Figures 9 and 10, the mottled fan-shaped density of the costophrenic angle being typical of this condition. Figure 9 shows a case in which the history proved that it was true bronchiectasis; moreover, in this case there was no lump in the hilum. It must be diagnosed as bronchiectasis and the underlying malignant lesion will only be discovered in an investigation for the cause of the bronchiectasis. Figure 10, in the absence of a confirmatory history of bronchiectasis and leucocytosis, we believe to be illustrative of pseudobronchiectasis due to the collection of blood, by gravity and aspiration, below the lesion, the blood-filled bronchial tree thus causing a density. Hence an appearance of bronchiectasis like that of atelectasis is suggestive of bronchial tumor.

If the lesion is really an early bronchial carcinoma there should be no other characters present. The unaffected lung must be perfectly clear, the upper portion of the mediastinum unthickened and there should never be an appearance as of metastasis distal to the lesion; at this early stage pleurisy is a rare manifestation. If there are appearances which might be taken as any of these, a search must be made for a larger primary lesion to keep the picture in proportion, or another lesion must be considered. For instance, a small unilateral density of the hilum with widening of the upper portion of the mediastinum is not typical of a malignant lesion with metastasis to the lymph nodes, but rather of Hodgkin's disease; a small lump of the hilum with peripheral metastasis will probably be entirely due to metastasis or there would be a larger primary lesion of the hilum.

To summarize, a unilateral density of the hilum, occupying the whole hilum, usually perceptibly separate from the mediastinum and ramifying into the parenchyma, especially if associated with apparent bronchiectasis or with atelectasis of the lung, must be carefully considered in the light of the clinical history before being dismissed as other than a malignant lesion. The cause of the appearance of atelectasis or bronchiectasis in the case of an elderly person must be found, although it is more difficult of accomplishment. These and various other data are shown in Table 1.

As the lesion grows, the appearances suggestive of a malignant tumor of the bronchus usually become concealed by secondary processes and the appearances are characteristic of a late stage of carcinoma of the lung in which there can be really no distinction between bronchial and parenchymal types. Such secondary processes fall into four groups: (1) stenotic,

(2) infective, (3) pleuritic, and (4) metastatic.

Stenosis may result from a bronchial growth obliterating the lumen of a bronchus, or from a parenchymal growth either occluding the lumen by pressure from without or later by eroding the wall and fungating into the lumen. In the absence of infection such stenosis will cause complete collapse of the lung but this is unusual. More often an atelectatic lung becomes infected.

TABLE I
ROENTGENOLOGIC DATA IN CASES OF PRIMARY MALIGNANT DISEASE OF THE BRONCHUS

	Diagnosis Proved by Bronchoscopic Biopsy	Diagnosis Probable	Diagnosis Proved at Necropsy	Total
Roentgenographic appearance:				
Density of the hilum alone	3	3	..	6
Density of the hilum associated with atelectasis	3	2	..	5
Density of the hilum associated with bronchiectatic appearance	2	1	..	3
Atelectasis alone	2	2	2	6
Bronchiectatic appearance alone	1	1	..	2
Massive tumor	2	1	..	3
(Concealed by fluid or metastasis)	..	..	3	3
Side involved:				
Left	3	7	1	11
Right	10	3	4	17
Lobe involved by atelectasis:				
Upper	..	1	1	2
Middle	2	..	..	2
Lower	2	..	..	2
Whole lung	1	3	1	5

Pyogenic infection is the most frequent secondary manifestation. It may occur either as bronchiectasis, pneumonitis or an abscess. Some observers regard the pleurisy of malignant disease as an infective complication, but our observations have not confirmed this view. Bronchiectasis follows partial obstruction of a bronchus, with pent-up secretion, stasis and infection as natural sequences. At first it will give the typical appearances of bronchiectasis with a fan-shaped area of irregular density and masses somewhat in the "bunch-of-grapes" form. The infection does not necessarily remain localized, however; large areas of lung tissue will become infiltrated as a result of pneumonitis which may give a variety of roentgen-ray appearances in which the actual lesion is lost.

Pleurisy is a frequent accompaniment of malignant tumors of the bronchus in the late stages. True malignant effusion is characteristically blood stained and non-purulent and has a marked tendency to recur after tapping. This is so constant an occurrence that when fluid is removed to allow roentgen-ray examination of the underlying lung, the examination must be made within the next few hours. This effusion gives the typical roentgenologic appearance of free fluid. It should always be a rule to remove any such fluid before expressing an opinion concerning the significance of the roentgen-ray appearance of the underlying lung. It has been suggested that the fluid be replaced with air as an aid to diagnosis.

Metastasis in the supraclavicular nodes has been noted as occurring quite early, and similarly the roentgen-ray picture may become altered by extension of the lesion to the mediastinal lymphatic nodes. The natural drainage is toward the nodes of the bronchial root and hence up the spine. There may be, for instance, thickening in the upper portion of the mediastinum due to metastasis to the lymphatics, that may easily be confused with Hodgkin's disease (Fig. 11). When nodes of the bronchial root are involved with a parenchymal tumor, the condition simulates tumor of the hilum.

The lungs themselves are a common site of metastasis for most malignant lesions. The picture of a primary carcinoma of the lung may easily be obscured by multiple metastasis in the other lung, or a small bronchial carcinoma may be overlooked in the picture which gives an impression of true miliary carcinosis.

DIFFERENTIAL DIAGNOSIS

The diagnosis cannot be made from the roentgenogram alone; the clinical history must complete the selection of the cases, and even then bronchoscopy may be performed when there is no malignant lesion,

but it will have been justified. In searching for roentgenograms illustrative of the differential diagnosis we have been able to select some in which the appearances of malignant disease are almost exactly duplicated, but the history was usually distinctive. There are many lesions which give a similar picture but which differ in the details that the roentgenologist must learn to observe.

The three characteristics of early malignant diseases are density of the hilum, atelectasis and bronchiectasis. We must consider, then, the other diseases that will give these appearances.

The hilum of the lung consists of part of the bronchus, vascular trunks and lymph nodes. In the normal hilum the bronchus and the nodes cast no shadows. A lesion in any of these structures may then produce an appearance of density of the hilum. Chronic bronchitis or pneumoconiosis results in generalized fibrosis, centered at the hilum and, roentgenologically, "density of the hilum." The density in all such conditions will always be bilateral and the degree of apparent infiltration will be much greater than that produced by malignant processes.

The affections of the lymph nodes are a little more difficult to distinguish as they may show unilaterality, although uncommonly. Any general adenopathy, such as leucemia, lymphoblastoma, Hodgkin's disease and the like, or any intra-abdominal lesion, infective or malignant, with involvement of the lumbar and dorsal lymph nodes, may reach over to the nodes of the bronchial roots and give shadows in the hilum. Even though they are not always visible on both sides, such lesions have a rounded contour and a smoothness of edge that is not like a primary malignant lesion, and, in general, this appearance is characteristic of the lymphatic enlargements. There are cases, however, in which lymphoblastomas take on an infiltrative character; usually the widening of the mediastinum will distinguish them but if the process is unilateral the differential diagnosis will be difficult and probably will only be settled by a test course of roentgen-ray treatment.

The nonmalignant enlargements of the hilum are then more or less easy to distinguish roentgenologically. A more difficult group to diagnose on roentgenologic evidence alone is that of other mediastinal lesions, which produce masses, apparently but not actually, in the hilum. Such lesions include aneurysm, carcinoma of the esophagus, benign tumor, gumma of the mediastinum, mediastinal abscess, and, rarely, Pott's disease with abscess, and chondroma or sarcoma of the spine. In their typical form none of these has marked resemblance to bronchial carcinoma but if they take on somewhat unusual forms they may easily be mistaken in the roentgenogram. The history or special forms of examination, such as the barium meal or roentgenogram of the spine, should make the diagnosis more certain. Usually the lesion shows a smoother and less infiltrating edge, but it is easy to be deceived with no evidence beyond a roentgenogram of the chest.

In discussing the masses due to nonmalignant enlargement of the lymph nodes in the hilum we omitted tuberculosis since this is the most important of all the differential diagnoses and we wished to discuss it separately. The history may often be of no help, as there is cough and hemoptysis, and loss of weight. In cases of pulmonary tuberculosis in adults there is often evidence of an associated affection in the hilum but the patchy areas of consolidation in some part of the lung, with a tendency to involve the apex (malignant lesions tend to spare the apex) and to cavitation is usually distinctive. There are rare cases with a true hilar disease of tuberculous nature. Only the follow-up investigation can prove the real nature of such lesions. However, it is rare to find tuberculosis without some of the usual characteristics of that disease.

In considering the diagnosis actually made in the first instance in our cases we were impressed with the frequency with which inflammation was suggested as a diagnosis. Abscess was diagnosed frequently. It will thus be seen that bronchial malignant lesions are most often wrongly diagnosed as inflammation, including various forms of pneumonitis, pneumonia, abscess and pleural affections

(plaques or localized collections of fluid). This error is made for two reasons: (1) early density of the hilum shows a separation from the mediastinum and is therefore likely to be confused with interlobar empyema or a circumscribed parenchymal collection of pus, and (2) the natural tendency is to consider the appearance of consolidation produced by atelectasis as a form of pneumonic consolidation.

A true collection of pus or pneumonitis (omitting of course obvious abscess with fluid levels) tends to be more circumscribed and less infiltrative than a malignant lesion and very often presents an appearance of multiplicity that no single carcinomatous lesion can produce.

An atelectatic consolidation of one lobe, besides showing a peculiarity of texture, will also show at least one sharply defined edge without the increased density along that edge which appears with the wall of an abscess or a cyst. It will always be continuous with the hilum.

There is seldom advanced bronchiectasis with a malignant obstruction, but it should be emphasized again that although such latent malignancy is rare, pure bronchiectasis may be due to malignant disease.

The inflammatory lesion, then, is the one that must be watched and in the end, if the suspicion of malignant disease cannot be excluded, the patient must submit to a bronchoscopic examination.

REPORT OF THIRTY-ONE CASES OF THERAPEUTIC ABORTION INDUCED BY ROENTGEN-RAY THERAPY*

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WITHIN the past nineteen months, we have administered roentgen therapy in the radiotherapy department of the Mt. Sinai Hospital, to 31 patients, with the object of producing therapeutic abortion. A number of these cases have already been reported by Wyser and Mayer.† They were all cases suffering from various chronic ailments which made interference with pregnancy absolutely essential. On account of their physical conditions, these patients were all considered poor surgical risks, and surgical interference would have been unquestionably accompanied by considerable danger. They were all forbidden future pregnancies, so the probability of producing sterilization with a temporary or permanent castration, was no contraindication; in fact it was considered a condition rather to be desired than to be avoided. That the danger of surgical interference in these cases is very real, was brought home to us by a patient who, despite my earnest solicitation, refused roentgen therapy, and who died during the necessary surgical procedure. There is no doubt that this patient would have been saved if she had chosen roentgen therapy, and I am sure that this procedure will be the means of saving many lives under similar circumstances.

These patients were all treated with the kind co-operation of the gynecological staff of the hospital, who referred the cases to us and who carefully watched over them during their confined period. We wish to express our thanks to them, especially to our gynecologist, Dr. Robert T. Frank, who has been of very valuable help to us in the treatment of these cases.

CASE REPORTS

CASE 1. R. B., aged twenty-three. One previous pregnancy; suffering from active pulmonary tuberculosis. Last menstruation on November 15, 1925. Duration of pregnancy two and a half months. Treated through a

† Wyser, D. D., and Mayer, M. D. Therapeutic abortion by means of the roentgen-ray. *Am. J. Obst. & Gynec.*, July, 1927, xiv, 62–68.

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single anterior center field (95 per cent skin unit dose) given on January 16, 1926. Fetus was expelled after an interval of twenty-seven days, on February 13, 1926. Fetus and membranes were expelled separately, with slight cramps, and very little bleeding. Treatment was followed by amenorrhea, which still persists. Castration symptoms very slight. General condition of patient much improved.

CASE II. M. L., aged thirty-five. Four previous pregnancies. Suffering from cardiac disease and uterine fibroid. Last menstruation on November 24, 1925. Duration of pregnancy two and a half to three months. Treated through a single anterior center field (95 per cent skin unit dose) given on February 15, 1926. Fetus was expelled intact, after a lapse of forty-two days, on April 12, 1926. Moderate bleeding and slight cramps. Treatment followed by amenorrhea, which still persists. Castration symptoms moderate.

CASE III. R. R., aged thirty-one. Four previous pregnancies. Suffering from a spinal cord tumor. Last menstruation May 12, 1925. Duration of pregnancy three to three and a half months. Treated through an anterior and a posterior field, with reduced dosage (80 per cent skin unit dose). Last treatment given on February 20, 1926. Uterus continued growing and labor was induced surgically in April, 1926, when a five months' fetus was found. This patient was rather heavy and was unquestionably under-dosed. With our present knowledge of the required technique she could have been most probably successfully aborted.

CASE IV. L. C., aged nineteen. Three previous pregnancies. Suffering from cardiac disease and epilepsy. Last menstruation on January 3, 1926. Duration of pregnancy two and a half months. Treated through an anterior and posterior field (80 and 90 per cent skin unit dose). Last treatment given on April 7, 1926. Fetus was expelled intact, after an interval of thirty-one days, on May 8, 1926. Slight bleeding. Treatment followed by amenorrhea, which still persists. Practically no castration symptoms. Epileptic attacks considerably diminished in number and severity.

CASE V. G. W., aged thirty-two. One previous pregnancy. Suffering from active pulmonary tuberculosis. Last menstruation on February 23, 1926. Duration of pregnancy two and a half months. Treated through an anterior and posterior field (85 and 90 per cent skin unit dose). Last treatment given on May 3, 1926. Fetus was expelled intact (but caught in the cervix from where it was easily extracted) after an interval of twenty days, on May 23, 1926. Severe cramps and moderate bleeding. Treatment followed by amenorrhea, which still persists. Castration symptoms very mild. General condition much improved.

CASE VI. A. R., aged thirty-eight. Four previous pregnancies. Suffering from cardiac disease. Last menstruation on March 15, 1926. Duration of pregnancy supposedly eight weeks. Treated through an anterior and posterior field (80 and 95 per cent skin unit dose). Last treatment given on May 18, 1926. Four weeks old fetus was expelled intact, after an interval of nineteen days, on June 5, 1926. Bleeding and cramps very slight. Treatment followed by amenorrhea, which still persists. Castration symptoms rather mild.

CASE VII. B. M., aged thirty-seven. Suffering from pulmonary tuberculosis and uterine fibroid. Last menstruation on April 4, 1926. Duration of pregnancy three and a half months. Treated through four fields; left and right anterior, and left and right posterior (90 per cent skin unit dose to each field). Last treatment given on June 19, 1926. Fetus was expelled intact, after an interval of twenty days, on July 8, 1926. Moderate bleeding and cramps. Treatment followed by amenorrhea, which still persists. Castration symptoms moderate.

CASE VIII. C. C., aged twenty-four. Seven previous pregnancies. Suffering from cardiac disease. Last menstruation on May 20, 1926. Duration of pregnancy two months. Treated through an anterior and posterior field (95 per cent skin unit dose). Last treatment given on July 10, 1926. Fetus was expelled intact, after an interval of seventeen days, on July 27, 1926. Moderate bleeding. Treatment followed by amenorrhea, which still persists. Castration symptoms moderate.

CASE IX. L. G., aged thirty-six. Four previous pregnancies. Suffering from cardiac disease. Last menstruation on June 3, 1926. Duration of pregnancy six to eight weeks. Treated through four fields; left and right anterior, and left and right posterior. (85 per cent skin unit dose to each field). Last treatment given on July 31, 1926. Fetus expelled intact, after an interval of twenty-three days, on August 20, 1926. Profuse bleeding before expulsion. Treatment followed by amenorrhea, which still persists. Castration symptoms mild. Patient gained 15 pounds.

CASE X. B. S., aged twenty-three. No previous pregnancies. Suffering from active pulmonary tuberculosis. Last menstruation on August 1, 1926. Duration of pregnancy one and a half months. Treated through an anterior and posterior field (80 per cent skin unit dose to each). Last treatment given on September 22, 1926. Fetus expelled intact (but caught in the

cervix from where it was easily removed) after an interval of twenty-three days, on October 15, 1926. Slight bleeding two days before abortion. Treatment followed by amenorrhea, which still persists. Practically no castration symptoms.

Case xi. H. G., aged forty-one. Three previous pregnancies. Suffering from nephritis and cardiac disease. Last menstruation on August 28, 1926. Duration of pregnancy two months. Treated through three fields; left and right anterior and left posterior (80 per cent skin unit dose to each field). Last treatment given on October 27, 1926. Fetus expelled intact, after an interval of one day after last treatment, on October 28, 1926. Most probably this abortion was not due to roentgen therapy, but was merely coincidental. Treatment followed by amenorrhea, which still persists. Castration symptoms fairly severe.

Case xii. D. C., aged thirty-one. Five previous pregnancies. Suffering from hyperthyroidism. Last menstruation August 22, 1926. Duration of pregnancy two and a half months. Treated through anterior and posterior field (80 and 90 per cent skin unit dose). Last treatment given November 17, 1926. Fetus expelled intact, after an interval of twenty days, on December 8, 1926. Treatment followed by amenorrhea, which still persists. Castration symptoms rather severe.

Case xiii. A. Z., aged forty. Eight previous pregnancies. Suffering from nephritis, large uterine fibroid, and very poor general condition. Last menstruation on October 13, 1926. Duration of pregnancy three months. Treated through an anterior and posterior field (90 per cent skin unit dose to each). Last treatment given on December 4, 1926. Fetus expelled intact, after an interval of eighteen days, on December 22, 1926. Very slight bleeding and cramps. Treatment followed by amenorrhea, which still persists. Practically no castration symptoms.

Case xiv. R. K., aged thirty. One previous pregnancy. Suffering from active pulmonary tuberculosis. Last menstruation on October 18, 1926. Duration of pregnancy six to seven weeks. Treated through an anterior and posterior field (90 per cent skin unit dose to each). Last treatment given on December 6, 1926. Fetus expelled intact, after an interval of twenty-eight days, on January 3, 1927. Very little bleeding. Treatment followed by amenorrhea, which still persists. Castration symptoms, practically none. General condition improved. Patient gained 6 pounds.

Case xv. M. F., aged thirty-three. Eight previous pregnancies. Suffering from cardiac lesion. Last menstruation on October 20, 1926. Duration of pregnancy seven to eight weeks. Treated through an anterior and posterior field (90 per cent skin unit dose to each). Last treatment given on December 20, 1926. Fetus expelled intact, after an interval of thirty-six days, on January 26, 1927. Slight bleeding only. Treatment followed by amenorrhea, which still persists. Castration symptoms mild.

Case xvi. I. A., aged thirty-eight. Three previous pregnancies. Suffering from acute arthritis, with adnexitis and deformity. Last menstruation on September 27, 1926. Duration of pregnancy two and a half months. Treated through an anterior and posterior field (80 and 90 per cent skin unit dose). Last treatment given on December 28, 1926. As patient did not abort by February 28, 1927, she was curetted. This showed degenerative changes in the chorionic villi. This patient might have aborted if more time had been allowed. Treatment was followed by amenorrhea, which still persists.

Case xvii. L. A., aged thirty-three. Three previous pregnancies. Suffering from cardiac disease. Last menstruation on November 21, 1926. Duration of pregnancy seven weeks. Treated through an anterior and posterior field (80 and 90 per cent skin unit dose). Last treatment given on January 9, 1927. As this patient did not abort by February 28, 1927, she was curetted. The fetus was found to have been dead for some time. It was the size of two and a half months. There is no doubt that if more time had been given, this patient would have aborted spontaneously. Treatment was followed by amenorrhea, which still persists. Castration symptoms moderate.

Case xviii. L. P., aged forty. Four previous pregnancies. Suffering from active pulmonary tuberculosis. Last menstruation on November 14, 1926. Duration of pregnancy two months. Treated through an anterior and posterior field (85 and 90 per cent skin unit dose). Last treatment given on January 16, 1927. Fetus was expelled after an interval of thirty-four days, with the placenta following five days later. Patient had considerable bleeding and cramps. Uneventful recovery, followed by amenorrhea, which still persists. Castration symptoms mild.

Case xix. M. W., aged thirty. Four previous pregnancies. Suffering from Graves' disease. Last menstruation on November 7, 1926. Duration of pregnancy, six weeks. Treated through an anterior and posterior field (80 and 90 per cent skin unit dose). Last treatment given on January 20, 1927. Fetus was expelled, after an interval of twenty-four days, on February 13, 1927. Placenta passed five days later—quite fibrotic—moderate bleeding. Treatment followed by amenor-

rhea, which still persists. Castration symptoms moderate.

CASE XX. D. B., aged thirty-two. Four previous pregnancies. Suffering from chronic nephritis. Last menstruation on December 15, 1926. Duration of pregnancy ten weeks. Treated through an anterior and posterior field (95 per cent skin unit dose to each). First treatment given on February 15, 1927; last treatment given on February 28, 1927. Fetus was expelled intact, after an interval of fourteen days following the first treatment (March 1, 1927). In this case the second treatment probably played no rôle as far as the abortion was concerned. It was given because we feared that she was under-dosed. Treatment followed by amenorrhea, which still persists. Castration symptoms moderate.

CASE XXI. F. R., aged thirty-two. Three previous pregnancies. Suffering from cardiac lesion and rheumatic arthritis. Last menstruation January 8, 1927. Duration of pregnancy three months. On account of patient's very large pelvic diameter (30 × 42 cm.) and weight (225 lb.), treatment was given through six fields; left and right anterior, left and right posterior, and left and right lateral (95 per cent skin unit dose to each field). Last treatment given on March 28, 1927. Fetus and membranes were expelled, after an interval of twenty-five days, on April 5, 1927. Treatment followed by amenorrhea, which still persists. Castration symptoms moderate.

CASE XXII. S. K., aged forty-two. Nine previous pregnancies. Suffering from tuberculous kidney and uterine fibroid. Last menstruation on October 10, 1926. Duration of pregnancy three and a half months. Treated through three fields; anterior center and right and left posterior (95 per cent skin unit dose to each field). Last treatment given on January 3, 1927. On March 5, 1927, while uterus stopped growing and fetus was determined to be dead, it was considered as a case of retention and patient was curetted. Fetus was found to have been dead for some time. This case cannot be considered as a failure, but rather a retention which sometimes occurs. Treatment was followed by amenorrhea, which still persists.

CASE XXIII. E. S., aged thirty-five. Four previous pregnancies. Suffering from cardiac disease. Last menstruation on December 8, 1926. Duration of pregnancy three months. Treated through anterior and posterior fields (90 and 95 per cent skin unit dose). Last treatment given on March 23, 1927. On April 25, 1927, patient had a hysterotomy performed. At this time a three and a half months old dead fetus and placenta were removed intact. There is no doubt that this patient would have spontaneously aborted if more time had been allowed.

CASE XXIV. B. R., aged thirty-one. Three previous pregnancies. Suffering from pelvic infection. Last menstruation on January 2, 1927. Duration of pregnancy two months. Treated through anterior and posterior fields (90 per cent skin unit dose to each). Last treatment given on March 3, 1927. Fetus was expelled, after an interval of twenty days, on April 19, 1927. Placenta passed two days later. Fairly severe bleeding. Treatment followed by amenorrhea, which persists. Castration symptoms mild.

CASE XXV. S. H., aged thirty-five. Four previous pregnancies. Suffering from cardiac disease. Last menstruation on February 12, 1927. Duration of pregnancy two months. Treated through four fields; right and left anterior, right and left posterior (90 per cent skin unit dose to each). Last treatment given on April 5, 1927. Uterus showed no increase in size after this, and, as months went by, it was considered either an error in diagnosis of gravidity, or a case of fetal absorption. Patient's condition was excellent, so it was decided not to interfere. On August 11, 1927, one hundred and twenty-eight days after treatment, patient passed a two and a half months fetus intact in a sac, in a very good state of preservation (Fig. 1). This is probably the longest case on record, as to time between treatment and abortion.

CASE XXVI. R. S., aged thirty-five. Three previous pregnancies. Suffering from cardiac disease. Last menstruation on January 15, 1927. Duration of pregnancy three months. Treated through four fields; right and left anterior, right and left posterior (80 per cent skin unit dose to each). Last treatment given on April 13, 1927. Fetus expelled, after an interval of twenty-four days, on May 5, 1927. Slight bleeding. Treatment followed by amenorrhea, which persists.

CASE XXVII. R. W., aged thirty-six. Seven previous pregnancies. Suffering from hyperthyroidism. Last menstruation on February 28, 1927. Duration of pregnancy five weeks. Treated through anterior and posterior fields (80 per cent skin unit dose to each). Last treatment given on April 27, 1927. Fetus expelled intact, after an interval of thirty-six days, on June 3, 1927. Very little bleeding. Treatment followed by amenorrhea.

CASE XXVIII. H. S., agedt wenty-three. Four previous pregnancies. Suffering from cardiac disease. Last menstruation on February 25, 1927. Duration of pregnancy three months. Treated through anterior and posterior fields

(80 per cent skin unit dose to each). Last treatment was given on May 3, 192-. Fetus was expelled intact, after an interval of thirty days, on May 2, 192-. Treatment followed by amenorrhea.

CASE XXIX. G. C., aged thirty-seven. Two

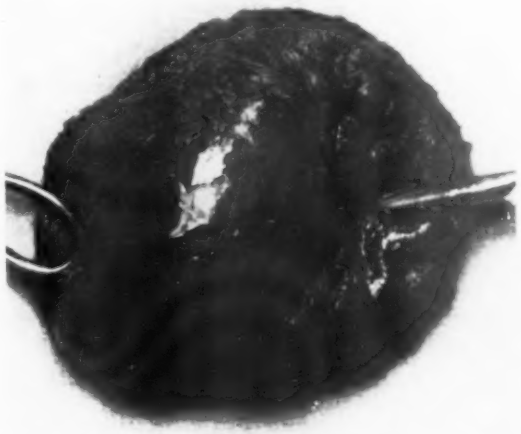

FIG. 1. Case XXV. Shows the intact ovum as it was spontaneously expelled 128 days after treatment.

previous pregnancies. Suffering from cardiac disease. Last menstruation on January 10, 192-. Duration of pregnancy three and a half months. Treated through anterior and posterior fields (90 per cent skin unit dose to each). Last

FIG. 2. Case XXXI. Shows ovum as expelled intact, seventy-six days after last roentgen-ray treatment.

treatment was given on May -, 192-. Fetus was expelled intact, after an interval of forty days, on June 16, 192-. Treatment followed by amenorrhea.

CASE XXX. J. B., aged twenty-nine. Suffering from cardiac disease. Last menstruation on April 25, 192-. Duration of pregnancy two months. Treated through anterior and posterior fields (85 and 90 per cent skin unit dose). Last treatment was given on July 12, 192-. Fetus was expelled intact, after an interval of twenty-two days, on August 4, 192-.

FIG. 3. Shows the same ovum as in Figure 2 with the sac opened and fetus removed, illustrating size and excellent state of preservation.

CASE XXXI. M. V., aged twenty-six. Seven former pregnancies. Suffering from cardiac disease. Last menstruation on April 5, 192-. Duration of pregnancy about three and a half months. Treated through anterior and posterior fields (80 per cent skin unit dose). Last treatment given on July 2, 192-. A four months old, dead fetus was expelled intact, after an interval of seventy-six days, on August 16, 192- (Figs. 2 and 3).

In tabulating these histories we find that the fetus was expelled spontaneously in 26 cases treated. In 21 of these it was expelled intact in the sac, and in 5 cases separately. In 2 cases, which were curetted (Cases XVII and XXII), the fetus was found to have been dead for some time, and would unquestionably have been expelled if more time had been given. A proof of this is Case XXV, in which the fetus was expelled spontaneously one hundred and twenty-eight days after the treatment. In Case XXIII a hysterotomy was performed after a lapse of thirty-two days following the treatment. At this time a dead fetus was

found, which most probably would have been spontaneously expelled in course of time. Case III was a total failure. Case XVI, while also a failure, showed at the time of the operation decided degenerative changes in the chorionic villi, which might ultimately have led to the death of the fetus. So we can say that out of the 31 cases treated, 26 were complete successes; 3 partial successes (death of fetus); one complete failure, and one questionable failure.

The duration of pregnancy in our cases was from four weeks to three and a half months. I see no reason why older pregnancies should not yield to the treatment just as well. None were referred to us, so we have had no opportunity of trying it out. The interval elapsed between the treatment and expulsion, disregarding Case XI (one day), Case XXXI (76 days), Case XXV (128 days), was from fourteen to forty-two days. There seemed to be no definite relationship between the duration of pregnancy and the interval of expulsion. There have been several papers published recently to the effect that if the abortion is not completed within fourteen days after the treatment, surgical interference should be instituted. Our cases show conclusively that this is an erroneous deduction. If it is found that the uterus has stopped growing a few weeks after the treatment, and the death of the fetus can be determined, unless the patient shows definite symptoms requiring interference, I think we might wait indefinitely, in the belief that sooner or later the patient will spontaneously abort.

In the great majority of our cases, there was very little bleeding and very little pain at the time of expulsion. The castration symptoms following the treatment were unusually mild—much milder than we generally see following castration for uterine fibroids. This probably can be explained on the theory that pregnant women have some substance circulating in their blood which has a tendency to counteract the effect of the cessation of the ovarian function. This probably persists for some time after pregnancy ceases.

TECHNIQUE

The cases were all treated with high voltage apparatus. The fields were planned and mapped out according to the Holfelder method of determining the direction of the ray and the dosage to be administered. We aimed to apply to the uterus, without protecting the ovaries, approximately 50 to 60 per cent of the skin unit dose; this is a little above our castration dose. We probably could have gotten along with less. After our failure in Case III, we decided to administer at least a full castration dose to all the patients, especially as they were all suffering from very serious ailments, and we were assured that castration would be of decided benefit to them. They were all patients who were forbidden any future pregnancies, and this was an ideal way of sterilizing them at least for some time to come, or even permanently in some of the cases. That we succeeded in this is shown by the fact that so far they are all still amenorrheic, and their general condition has been decidedly benefited thereby.

The number of fields we used were one large anterior field in 2 cases (our first two cases), a large anterior and a large posterior field in 21 cases; three fields in 2 cases; four fields in 4 cases, and six fields in one case. The number of fields to be used was determined by the number of portals of entry necessary to administer the required depth dose.

The voltage used was generally 200 kv. and the milliamperage 4. The distance generally depended upon the size of the field and the depth dose to be administered, as shown by the Holfelder charts. (It was usually 40 or 50 cm.) The filter was always 0.5 mm. Cu plus 1 mm. Al. We limited ourselves to administering not more than 90 per cent skin unit dose to any field, with the exception of a few fields where we used 95 per cent but never above this. At no time during the treatment did we see a severe dermatitis in any of our cases.

It is very probable that for patients where it is important to preserve the ovarian function, a technique can be developed which will produce an abortion with very little or no disturbance of the menstrual cycle. Ganzoni and Widmer* treated 8 patients, with two narrow fields anterior and posterior directly over the center of

* Ganzoni, M., and Widmer, H. Erfahrungen über den Rontgenbort. *Strahlentherapie*, 1925, XIX, 485–504.

the uterus, protecting the ovaries as much as possible. In these cases they had 3 failures. The others spontaneously aborted. In ⁻ of the cases treated there was no disturbance in the menstrual function following the treatment. On account of the large percentage of failures, they decided to try one large anterior field 10 × 15 cm. in their next series of ⁻ cases. Here they succeeded in producing a spontaneous abortion in every case. This was followed by undisturbed menstruation in 2 cases; an amenorrhea lasting seven months in one case; eight months in 2 cases, and irregular menstruation in the 2 other cases.

SUMMARY AND CONCLUSIONS

1. Therapeutic abortion induced by roentgen irradiation is of great value, especially in cases where surgical interference would be connected with danger to the patient.

2. It is of especial value in cases where a temporary or a permanent castration is desirable.

3. The small percentage of failures can most probably be avoided by carefully working out the proper technique for each individual case.

4. The treatment properly applied is connected with no danger to the patient whatever.

5. There seems to be no definite connection between the duration of pregnancy and the interval between treatment and expulsion of the fetus.

6. The duration of pregnancy in our cases has been between four weeks and three and a half months, but there is no doubt that cases of longer duration would also respond to the treatment.

7. The interval of time between treatment and expulsion in our cases was between fourteen and forty-two days, although in one case the fetus was expelled intact after seventy-six days and in another one hundred twenty-eight days after the treatment.

8. If it is found that the uterus has stopped growing a few weeks after the treatment, and the death of the fetus can be determined, unless the patient shows definite symptoms requiring interference, I think we might wait indefinitely in the belief that sooner or later the patient will spontaneously abort.

DISCUSSION

Dr. Wm. B. Bowman, Los Angeles, Calif. I should like to report a case of a woman thirty-five years of age weighing over 250 pounds who consulted a surgeon for excessive and irregular menstrual flow. After consultation it was decided that she had a fibroid tumor and upon her refusal of operation she was referred to a well-known roentgenologist who treated her for fibroid. Five months later she was sent to me for roentgen examination of her abdomen, which was becoming gradually larger, in spite of the fact that she had had high voltage treatment such as is described by Dr. Stern in his paper. We found about an eight months fetus. She was delivered one month later of a 3½ pound baby. We have been observing the child since and it seems to me a normal, healthy child except that it is undersized.

Dr. G. E. Pfahler, Philadelphia. Has it been growing normally since birth?

Dr. Bowman. Yes, the fact that it is small now, I think is due to the fact that it was only a 3½ pound baby when it was born.

Dr. L. E. Pariseau, Montreal, Canada. There is a question raised in Dr. Stern's paper that seems to me to need explanation. According to Bergonié and Tribondeau's law, embryonic cells are exceedingly radiosensitive but the cells of a fetus four weeks old are already highly differentiated cells; although the mass is in embryo the cells are not embryonic. What does Dr. Stern think is the mechanism of abortion in these cases? It cannot be a direct action of the roentgen ray on cells that are radiosensitive since these cells are already highly differentiated at four and a half weeks.

Dr. C. L. Martin, Dallas, Texas. I should like to ask Dr. Stern what was the farthest advance of pregnancy in which the treatment was successful. Recently I read an article in which it was stated that abortion could not be produced with radiation excepting in the early months of pregnancy. I had an experience along that line about a year ago in that I had a patient with carcinoma of the cervix, well advanced, sent to me for treatment in the seventh month of pregnancy. I treated her with 3,600 mg-hr. of radium and four full doses of roentgen rays through four ports of entry through the pelvis. We had an excellent result from the treatment of the carcinoma and the pregnancy was not interfered with at all. An artificial labor was induced before full term because it was feared that a full term

child could not be delivered through the cervix which had been treated by radium. This experience led me to believe that the treatment described by Dr. Stern will probably not be successful in the latter months of pregnancy.

DR. STERN (closing). The question asked by Dr. Pariseau as to the cause of abortion after roentgen-ray treatment has been widely discussed. Some believe that the treatment results in degeneration of the chorionic villi resulting in the death of the fetus. Others believe—and I belong to this class—that the action is upon the fetus itself. While it is true that the cells are already in a fair stage of development at eight to twelve weeks, nevertheless we know that glandular structure is very sensitive to radiation and I have always believed that we produce abortion by destroying the development of the glandular function of the embryo and the fetus dies a natural death.

In answer to Dr. Martin's question, I stated in my paper that the oldest case of pregnancy that we had was three and a half months. I believe that they could be treated successfully up to at least four and a half months, but beyond that I am not sure.

I would like to discuss another question that has been raised a number of times, that is, whether abortion can be produced without interference with the menstrual cycle. In our own cases we did not have to consider that because they were all cases in which the gynecologist believed complete castration was desirable. In all of them we used as much as 50 per cent depth dose although I believe the results could have been obtained by the use of 35 per cent. There is no doubt in my mind that a method can be worked out by which abortion can be produced without permanent interference with the menstrual cycle.

RADIUM THERAPY IN TUBERCULOUS CERVICAL ADENITIS*

BY G. ALLEN ROBINSON, M.D.

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TUBERCULOSIS of the cervical lymph nodes according to Fraser occurs by way of the blood stream in about 10 per cent of the cases. He states that haphazard and often coincident appearance of multiple diseased nodes suggests a blood infection, while the local development of a tuberculous lymph node or those immediately surrounding a lymphatic infection is suggested and more especially if the affected nodes lie in lymphatic connection with such obvious areas of absorption as the tonsils. Tuberculous adenitis is far less common than it was two decades ago, and would appear to be due to better oral hygiene, early tonsillectomy and adenectomy, and pasteurization of milk.

Early surgical removal of localized tuberculous lymph nodes is a conservative procedure, but extensive dissection must be tempered, according to Hanford, with an eye to the ultimate appearance of the neck and safety to the patient and surrounding structures. The aim of treatment is a good cosmetic effect, which shall be permanent. In 75 per cent of the cases reported by Smith and Hopkins complete excision was impractical or impossible. A clinical cure was obtained by roentgen-ray treatment in 12 of their 21 cases, 6 were markedly improved, 2 showed only slight improvement, and one died of unknown causes. Amundsen's results with roentgen rays showed 81 per cent cured of 32 patients with simple enlargements of the glands; 49 per cent of 32 with periadenitis in addition; and 77.4 per cent were cured of the 53 with suppuration and fistulas in the glands. The total cured thus averaged 66 per cent. All were examined from two to nine years since treatment. Of 50 cases of tuberculous adenitis treated by Gosse with radium, 37 were cured, 9 improved, 3 not improved, one dead. Tischy states that re-examination two years or more later showed recurrence in 74 per cent of 39 cases of tuberculous glands treated by operative measures but

* From the Radium Department, Manhattan Eye, Ear, Nose and Throat Hospital. Read at the Twelfth Annual Meeting, AMERICAN RADIUM SOCIETY, Washington, D. C., May 16–17, 1927.

there was a recurrence in only 11 per cent of 27 that had been treated by irradiation. All were selected cases with enlarged or softened glands, but no fistulas.

The three pathological types are: the caseating, the lymphoid, and the fibrous. The caseating variety is the most common. Superadded pyogenic infection is often present increasing the caseous material, producing periadenitis, and discharging sinuses. Radium treatment in tuberculous adenitis should be considered as an adjunct to the other well-known measures employed in the treatment of tuberculosis. The foci of infection should be determined and eradicated; excessive strain and fatigue avoided; proper diet, fresh air and sunshine are essential.

Radium produces an inflammatory reaction in the tissues which hastens the healing of discharging sinuses, and causes a gradual shrinkage of the tuberculous lymph nodes. Many nodes, particularly those of the lymphoid type, will entirely disappear, while others remain as fibrous nodules. Healing occurs through a hyaline change or general scarring, and sometimes with a deposit of calcium which is tightly encased in a fibrous capsule. J. C. Mottram writes as follows:

"The cellular changes which follow the irradiation of tubercular lymphatic glands finally result in fibrosis. There is an early disappearance of the lymphocytes, which either disintegrate or are phagocytosed by macrophages. The lymphoid myeloblasts, except after large doses of radium, do not persist, and later may reform lymphocytes. The lymphoid follicle atrophies, only the central cells remain. The endothelial meshwork of the glands remains little altered, except for a great increase of fibrous tissue so that the whole gland, shrunken from the loss of lymphocytes and other cells comes to consist of narrow spaces lined with endothelial cells running through thick fibrous tissue. In this tissue the tubercles persist more especially the giant cells, and here tubercle cells have been found persisting many months after radiation. It has been concluded from these appearances that the good clinical results are due to the creation of a site unfavorable to the growth of the tubercle bacilli, rather than to any direct action of the radiation on the bacillus. The dose of radiation given is always very much less than the lethal dose for the bacillus, nevertheless a direct action on the bacillus may also be a factor, for the reason that it is well known sublethal doses of radiation effect a lowering of the virulence of the bacilli."

TECHNIQUE OF RADIUM APPLICATION

There is no set rule for the treatment of these cases. The lymph nodes to be treated are carefully located and palpated, and with a dermographic pencil areas are marked out on the overlying skin. Incision or aspiration of the pus or caseating material is indicated before irradiation. A large firm mass will require more irradiation and a deeper penetration than soft superficial nodes. In most cases 100 mg. radium element in three or four tubes strapped to a block of balsa wood, 5 by 7.5 by 3 cm. for a period of fifteen hours will cause a rapid regression of the nodes. The gamma rays are employed and each square centimeter of skin surface receives 40 mg-hr. at 3 cm. distance, which is approximately one-half an erythema dose. Full erythema doses should be avoided because of the possibility of latent skin atrophy. The treatments are repeated at monthly intervals, and five or six applications are necessary.

SUMMARY

In the series of 25 cases of tuberculous adenitis treated by radium, 18, or 72 per cent, are clinically well, 2 are dead, 5 improved, but still have active nodes. Radium, if properly used is a safe procedure and gives a high percentage of cures. Unless sinuses are present, no scars are left. Radical operation is contraindicated because of the tendency to recurrence and the disfiguring scars.

DISCUSSION

DR. H. H. BOWING, Rochester, Minn. I have noted the frequency of tuberculous adenitis in patients from the rural districts. Conservatism is without doubt the keynote in the treatment whether surgery, radium or roentgen ray is the method used. I have seen typical disfiguring tissue changes produced in the treatment field following the radiologist's too vigorous attempts to achieve "results." We must keep in mind that we are treating an inflammatory disease, and that light rather than heavy treatment must be employed If there is sinus formation and the nodes are cystic in areas scars will occur following irradiation. We cannot hope to bring about absorp-

REPORT OF CASES

No.	Name	Age	Sex	Examination	Duration of Disease	No. of Treatments	Duration of Treatments	Total No. of Mg-hr.	Duration of Observation	Results
1	C. D.	25	F	Firm mass 4 × 3 × 2 cm. in submaxillary region.	1 yr.	5	7 mo.	3,500	3 yr.	Satisfactory.
2	V. M.	38	M	Large firm mass 6 × 6 × 4 in. in right neck.	2 mo.	5	8 mo.	6,240	2 yr.	Satisfactory.
3	A. S. F.	27	M	Hard mass of nodes 6 × 8 × 4 cm. in left submaxillary region with a chronic suppurating sinus.	4 yr.	5	18 mo.	14,650	2 yr.	Improved, mass one-half the original size. Sinus healed, still under observation.
4	P. R.	25	M	Large hard mass 8 × 5 × 3 cm. in left submaxillary region. Had several low voltage treatments in Germany 3 yr. previously. Skin shows considerable atrophy.	4 yr.	1	.....	3,200	1½ yr.	Satisfactory.
5	H. K.	10	M	Firm discrete mass 4 × 4 × 6 cm. in left maxillary region.	10 mo.	9	2 yr. 9 mo.	14,000	3 yr.	Satisfactory, a small fibrous mass remains.
6	P. M. A.	33	F	Numerous scattered firm nodes; both sides of neck have increased in size during past 6 mo. Numerous incisions.	6 yr.	7	15 mo.	13,400	3 yr. 6 mo.	Satisfactory, few fibrotic nodules remain.
7	M. G.	22	F	Firm swollen nodes 4 × 3 × 1 cm. anterior angle of neck. Numerous discrete swollen nodes 1 to 3 cm. on both sides of neck.	4 yr.	2	6 wk.	2,800	3 yr.	Satisfactory.
8	V. McA.	19	F	Numerous scattered nodes both sides of neck.	12 mo.	2	5 wk.	3,100	2 yr. 3 mo.	Satisfactory.
9	A. D.	11	F	Large discrete lymph nodes both sides of neck. Deep sinus left submaxillary region. Mother has pulmonary tuberculosis.	1 yr.	6	2 yr. 9 mo.	13,700	3 yr. 6 mo.	Satisfactory.
10	Van F.	42	F	Several discrete nodes in left side of neck 2–4 cm. in diameter; 14 low voltage treatments 2 yr. before. No atrophy of skin.	6 mo.	1	.....	1,120	3 yr.	Satisfactory; fibrous nodules remain.
11	H. F.	5	M	Suppurating nodes both sides of neck. Incisions have been made.	3 yr. 6 mo.	6	2 yr. 6 mo.	5,900	2 yr. 6 mo.	Improved, a few nodules remain.
12	N. S.	16	F	Large diffuse soft nodes right side of neck; 6 lesions on face ulcerated, from 2 to 4 cm. in diameter.	3 yr.	9	2 yr. 3 mo.	14,000	4 yr.	Improved; face lesions healed. Mass in neck is smaller.
13	H. H.	27	F	(Colored.) Diffuse soft nodes swollen, tender, both sides neck, loss of weight, advanced pulmonary lesions.	1 yr.	6	1 yr.	14,400	2 yr. 6 mo.	Died pulmonary tuberculosis.
14	D. N.	25	F	Diffuse large hard nodes both sides of neck, more marked on the left. Incipient pulmonary tuberculosis.	4 mo.	6	2 yr.	11,000	2 yr	Small fibrous mass left side of neck. Lungs clear, after 6 mo. treatment in Santa Fe, New Mexico. Has gained 16 lb. in weight, Satisfactory.
15	L. R.	18	F	Right side of neck has a soft mass 10 × 10 × 4 cm. In submental region is a soft mass 4 × 4 × 2 cm.	6 yr.	4	5 mo.	13,400	1 yr.	
16	E. B.	22	F	Entire right side of neck diffusely infiltrated with a deep suppurative sinus anteriorly.	6 mo.	2	2 mo.	3,300	1 yr. 9 mo.	Satisfactory. Few fibrous nodules, sinus healed.

No.	Name	Age	Sex	Examination	Duration of Disease	No. of Treatments	Duration of Treatments	Total No. of Mg-hr.	Duration of Observation	Results
17	A. G.	27	F	Dissection 1 y m p h nodes right side of neck 10 wk. previously. Swollen mass right submaxillary region 8 × 6 × 3 cm., with chronic suppurative sinus present.	4 mo.	3	6 wk.	2,170	2 yr. 9 mo.	Satisfactory.
18	L. H.	20	F	Previous excisions in France. Diffuse soft nodes both sides of neck with several sinuses.	5 yr.	10	5 yr.	3,665	7 yr.	Satisfactory.
19	D. F.	20	M	Excision 5 yr. previous, lymph nodes right neck 10 × 7.5 × 4 cm.	3 yr.	9	3 yr.	11,300	5 yr. 3 mo.	Satisfactory. A small fibrous mass remains.
20	J. L.	14	M	Previous excisions. Several confluent nodes forming ulcerating mass in right neck 12.5 × 5 × 3 cm.	3 yr.	17	6 yr.	20,530	6 yr.	Improved. Had relapse after 2 yr. A small mass remains which may cause trouble.
21	M. G.	26	M	Previous excisions. Extensive suppurating node involvement right neck. Evidence of healed tuberculosis right upper lobe.	2 yr.	12	3 yr. 6 mo.	24,260	3 yr. 9 mo.	Satisfactory. Fibrous nodules remain. No active pulmonary tuberculosis.
22	M. T.	8	F	Adenoid and tonsil operation 4 yr. ago. Complete cervical adenectomy on right side 2 yr. later. Swelling behind right tonsil pillar. Several swollen lymph nodes 1 to 3 cm. in diameter.	3 yr.	2	6 wk.	2,250	2 yr. 3 mo.	Satisfactory.
23	P. O.	12	F	(Colored.) Previous excisions extensive suppurating nodes both sides of neck. Right eye tuberculosis.	1 yr.	6	1 yr.	8,950	2 yr. 4 mo.	Satisfactory. Fibrous nodules remain, eye condition healed.
24	J. A.	16	M	Recent operation right side of neck extensively involved discharging sinus.	1 yr.	8	1 yr.	4,950	2 yr. 7 mo.	Satisfactory.
25	J. S.	43	M	Entire left side of neck a huge suppurating mass of lymph nodes. *Previous aspirations.	3 yr.	10	2 yr.	35,000	7 yr.	Neck healed 5 yr. Patient died of influenza.

tion of the necrotic material by irradiation. In the hypertrophic state, to be sure, the disease may be favorably influenced by moderate irradiation. It is our custom to follow the surgical procedure with surface irradiation. There is no doubt that the physician in charge can do much to further the work of the radiologist. Much depends on the supporting treatment, such as cleaning up foci of infection, and regulating the patient's hygiene.

Dr. George E. Pfahler, Philadelphia. I have treated more cases of tuberculous adenitis with roentgen rays than with radium. Both can be used to good advantage. The one great thing to keep in mind is not to overtreat these patients. We must not produce an atrophy or telangiectasis. Not only should we treat by suberythema dosage, but we should calculate our cumulative dose value so that we will avoid atrophy. We can bring about atrophy and telangiectasis by accumulations of small doses, or by too large doses. Sometimes the lymph nodes become fibrous, and sometimes calcareous, and it is important to know when to stop treatment. The too enthusiastic man will keep on applying radium over and over until he has produced this atrophy. In one case I have seen epithelioma develop on the base of this atrophy. The total value of the treatment of these cases should not exceed 6 to 8 erythema doses in any length of time. This should be carefully calculated.

Dr. Henry K. Pancoast, Philadelphia. The correct diagnosis of the condition is one of the important parts in successful treatment. When one has had a large experience with lymphadenitis and lymphadenoma he finds that he can make mistakes in diagnosis very readily and he may go on treating a case as tuberculous adenitis which is something else.

It may be possible to confirm the diagnosis by the roentgen ray and the finding of calcifications. This might be also the means of determining whether we have gone as far as we should with treatment. If the glands calcify and become much reduced in size, it will show us that we have gone far enough. In all cases of lymph gland enlargement it is best to pick out an easily accessible gland and remove it for biopsy.

PHYSICAL AND BIOLOGICAL PROBLEMS IN HELIOTHERAPY

II. A MEASURING DEVICE FOR ULTRAVIOLET RADIATION *

BY

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IN the first paper in this series,[1] we related our experience with the photochemical method of standardizing quartz mercury vapor lamps; following the recommendation of Keller, the U.V.U. was adopted as clinical dose unit. It represents the medium erythema dose for adult human skin. Although the performance of this test does not require special chemical training nor an unreasonable amount of time nor cumbersome apparatus, every physician would undoubtedly prefer a device that can be used in the same fashion as the voltmeter. We have, therefore, directed our efforts to that end, and present in this article the results of experiments leading to the construction of a simple measuring apparatus for ultraviolet radiation as emitted particularly by the quartz mercury vapor lamp in clinical practice.

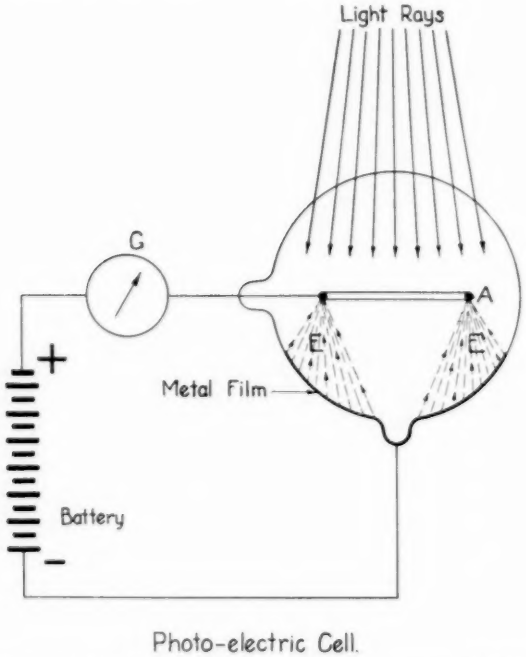

FIG. 1. Photoelectric cell. The light waves striking the metal film (cathode) release electrons. The galvanometer indicates then the current flowing through the cell.

Among the methods for recording the intensity of light, the one based upon the photoelectric effect seemed to offer the most desirable properties. When rays of certain critical wave length strike a metal plate, it will emit electrons. This phenomenon can easily be demonstrated by an arrangement as shown in Figure 1. The cell consists of a glass vessel in which the cathode is formed by a thin metal film while the anode can be made of a grid of fine wire or a loop; the vessel is sealed gas tight, evacuated, and then filled with a neutral gas, such as argon. If light rays reach the metal cathode, the released electrons will gain speed under the influence of the potential impressed upon the cells and a current flows. This can be proved by a deflection of the galvanometer in the

* Read at the Twenty-eighth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY Montreal, Canada, Sept. 20–23, 1927.

circuit. A photoelectric cell which would be fitted for our special purpose should be fairly constant and have its optimum of sensitivity in the therapeutic region of the ultraviolet spectrum. That is, according to our present knowledge at perhaps 3500 and 2500 Angströms. As Sonne and Rekling's[2] experiments with monochromatic ultraviolet light have shown, the lines 3020 to 2970, 2800 to 2650 and 2530 of the mercury spectrum cure rickets; very little effect was observed from lines 2480 and 2400; the effect of line 3130 was questionable while line 3660 did not exert any therapeutic action at all.

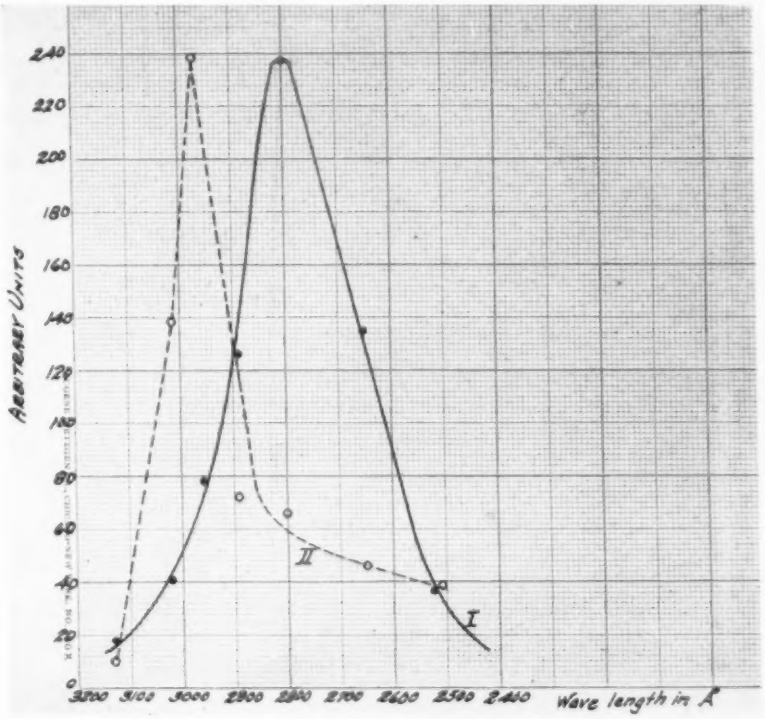

FIG. 2. The straight line represents the relative sensitivity of the cadmium cell; the dotted line taken from Hausser and Vahle illustrates the relation between wave length and erythema.

It is known that cadmium responds only to radiation of less than 3660 Angströms and is most sensitive to rays below 3200 Angströms. Cadmium, therefore, represents a desirable metal for the cathode material in the photoelectric cell which answers part of our requirements. By selecting a glass which transmits only the shorter ultraviolet rays as material for the bulb of the photoelectric cell, the maximum point of sensitivity can be shifted into the desired region. This we assume at about 2900 Angströms according to the above investigations of Sonne and Rekling and the findings of Hausser and Vahle,[3] discussed in detail in the first paper. A photoelectric cell of that nature has been suggested by Dorno[4] who comments very favorably regarding their constancy. Its uviol glass bulb transmits almost 90 per cent of the intensity at about 3020 and 56 per cent at 2810 Å (thickness 1 mm.). The relative sensitivity curves of a cadmium cell with a uviol glass bulb and the skin erythema curve as published by Dorno are given in Figure 2, while Figure 3 shows the voltsensitivity of one cell. He used a quartz spectrograph of very high dispersive power, the lenses having a surface of 80 × 80 mm. and 120 mm. in diameter. The intensity of each of the 70 lines of the mercury spectrum examined were measured with a thermopile.[5] In order to illustrate the difference between potassium, zinc, and cadmium as cathode in the photoelectric

cell, Table 1 is reprinted from the experiments of Elster and Geitel,[6] demonstrating if one has either a very sensitive galvanometer available or chooses the arrangement

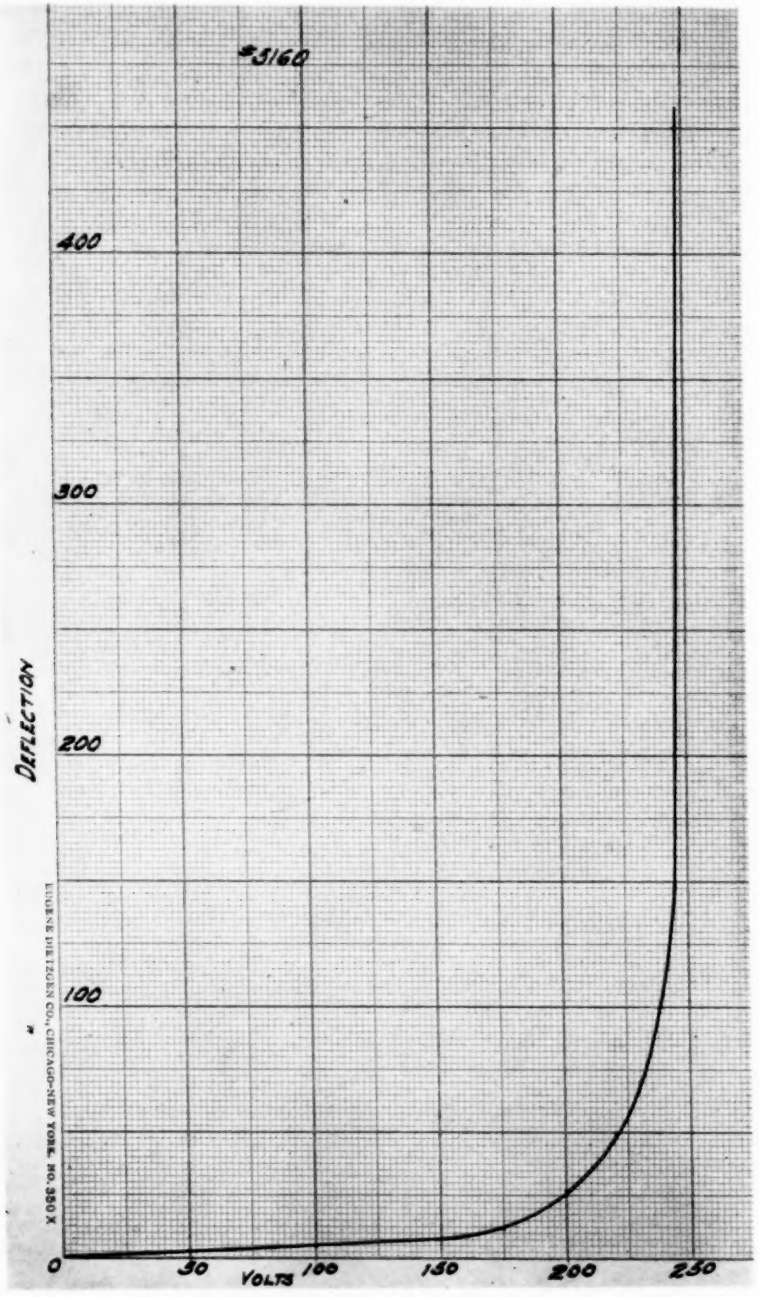

FIG. 3. Influence of the potential at terminals of the cadmium cell on its sensitivity to ultraviolet radiation.

clearly the reason for selecting cadmium for our purpose.

The measurement of the photoelectric current with such a cell is relatively simple suggested by Dorno who uses an electrometric method. It might be called "discharge method"[7] because instead of the galvanometer, he employs an electroscope

which is charged first.* The photoelectric current discharges the instrument and the drop of the leaf over a scale is observed. A similar device but using quartz instead of uviol glass has been described by Griffith and Taylor.[8] Their instrument is designed for and adapted to the calibrating of therapeutic lamps in the ultraviolet region. It would be much simpler if one could use an electrometer of ordinary sensitivity reading on a scale of arbitrary units the output of a mercury vapor lamp. The only way open seems to be one whereby the photoelectric current is amplified; this has been suggested by Dorno† who took advantage of the amplification device provided in the Siemens dosimeter[9,10] which is employed in deep roentgen therapy. That instrument is rather expensive and not manufactured in this country. Our method although in principle the same, being an amplification of the photoelectric current, uses a different arrangement of the tube circuit.

TABLE I

Wave Length Range in Ångströms	Mercury Arc			Sun (h = 26°)		
	K	Zn	Cd	K	Zn	Cd
red–4000	46.2*	0.02	0.0	81.0	0.6	0.0
4000–3900	34.2	1.48	0.0	19.0	42.3	2.2
3900–3500	2.1	3.10	0.0	0.0	12.1	3.1
3500–2240	17.5	95.40	100.0	0.0	45.0	94.7

* Percentage of photoelectric current.

The use of a three electrode tube as an amplifier for small currents is well known in the physical laboratory. An arrangement which recent tests have shown to be well adapted to the present problem is illustrated in the diagram of Figure 4. A radio "B" battery, OE, having a potential of from 180 to 270 volts, serves as a source for the photoelectric cell, as well as supplying 90 volts for the plate circuit of an ordinary amplifier tube. The storage battery H feeds the filament. Across the resistance "S" in the plate circuit, a cell "F" in series with a microammeter "G" is connected as shown, and by means of varying the potential drop across "S" an adjustment of the microammeter to zero current is obtained. The e.m.f. of the cell is then exactly equal to the drop in voltage across the section of resistance "S" thus shunted out, and "G" is sensitive to slight changes in the plant current. The circuit is now ready for calibration.

When the photoelectric cell is exposed to ultraviolet radiation a current will flow

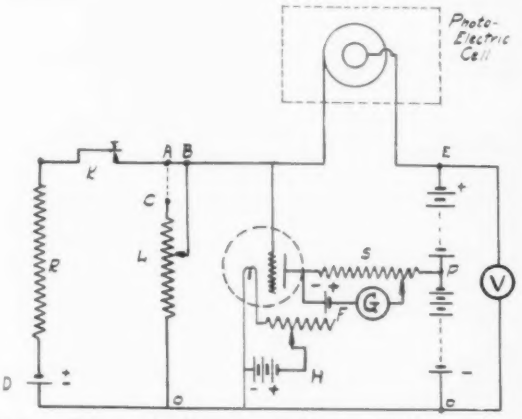

FIG. 4. Schematic diagram of the circuit (for explanation, see text).

through the grid circuit resistance L, and the potential of the grid will be raised above O by an amount equal to I × L, where I is the value of the photoelectric current. This elevation of grid potential will cause an increase in plate current, and a deflection of the recording meter "G." With proper choice of bias potential and grid leak "L," the change of plate current can be made large, and full advantage of the amplifying properties of the tube secured. When operating on the straight portion of the grid potential—plate current characteristic curve, deflections of the meter "G" are strictly proportional to values of the photoelectric current I (see Fig. 5). This is also shown by the curves A and B in Figure 6 which represent measurements taken with a sensitive wall-type galvanometer (A) and with the amplification device (B). Thus with the photoelectric cell receiving an amount of ultraviolet radiation representing one U.V.U., L may be adjusted to give a convenient deflection on the micro-

* F. Dannmeyer has recently measured with this arrangement the output of a number of ultraviolet lamps. (*Strahlentherapie*, 1926, xxii, 738.)

† Since the presentation of this paper we have found further references regarding the amplification of a photoelectric current. See W. Gerlach. Materie, Elektrigitaet, Energie. Dresden, 1926, p. 207.

ammeter "G," and the calibration of its scale in erythema units is now possible.

This calibration is permanently secured by means of an auxiliary circuit containing a standard dry cell "D," and a high resistance "R" in series with a key "K," connected to the grid circuit as shown. With "K" closed, and the photoelectric cell unexposed to ultraviolet light, the value of R is adjusted until the deflection of "G" adopted as standard, is duplicated. The value of 15 megohms in series with a variable grid leak. When once in adjustment, it was found unnecessary to readjust "L" over a period of several weeks, and readings were duplicated within an error of a few per cent. It is necessary to have a double scale voltmeter to check the e.m.f. of the battery OE, and of the cell D. These must be renewed as soon as the voltage falls appreciably below normal. The entire circuit is mounted in a compact and ser-

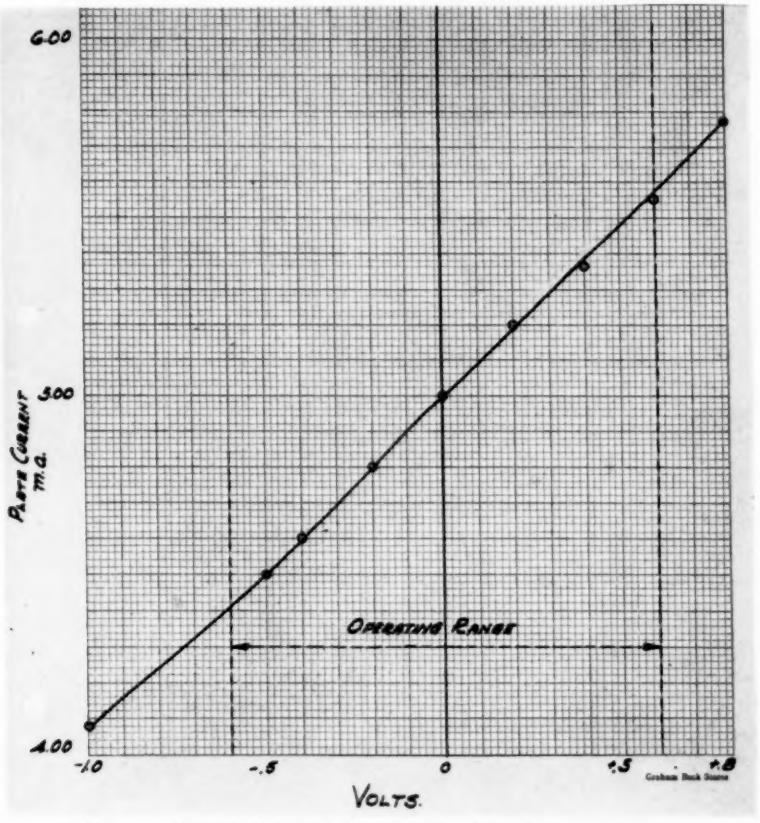

FIG. 5. Characteristic of the tube used in the experiments.

resistance R is now permanently fixed, and the whole circuit mounted in a highly insulated case. The calibration is practically independent of variations in the tube circuit,* and of ordinary differences which exist between tubes of the same model made by a competent manufacturer. In the circuit used in our tests "R" had a viceable unit, with convenient dial mountings for microammeter, voltmeter and resistance potentiometer controls (see Fig. 7).

The calibration of the scale of the milliammeter in erythema units was carried out by comparison with the deflection of the above mentioned high sensitive galvanometer connected to a cadmium photoelectric cell, the constancy of which was well enough known. By carefully measur-

* As soon as a continuously variable high resistance potentiometer is developed, this will be connected between A and O, and the connection removed between A and B. The resistance of the circuit ORACO will then be constant for all adjustments, and the calibration absolutely independent of tube circuit variations.

ing the output of several mercury vapor lamps at regular intervals over a period of one year,* corresponding to approximately

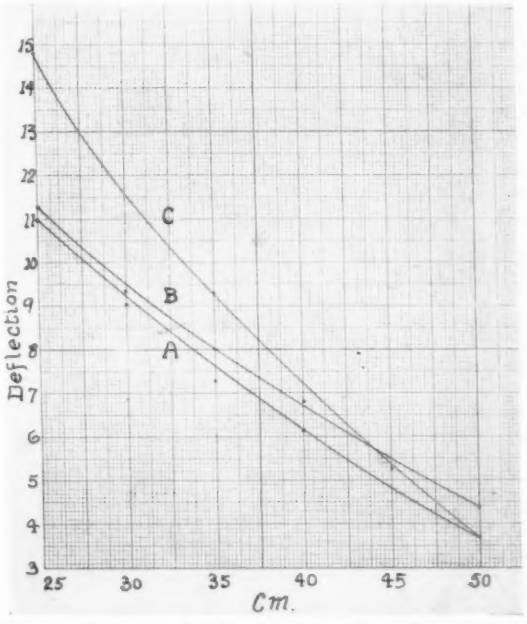

FIG. 6. Linear relation between intensity of light and deflection of galvanometer; control of inverse square law.

1200 hours of use, and by checking each time the results of the physical investigation by skin tests, a rather well-defined and reproducible erythema dose or "ultraviolet unit" is now available in our laboratory.

It appeared that, for instance, in one of our measuring units a deflection of eleven divisions of the meter scale at 25 cm. burner-cell distance corresponded to an erythema time at the double burner skin distance of three minutes. This relation varies of course and each apparatus must be calibrated independently.

We were also able to verify our previous findings based on the photochemical test, that the inverse square law does not hold true in the case of the mercury vapor lamp. In Figure 6, Curves A and B are the results of measurements and Curve C is calculated according to the inverse square law.

The testing of a lamp with our instrument takes very little time. After the connections are made and the potential of the photoelectric cell and the standard dry battery has been checked (voltmeter V and switch A, pushbutton P), switch B is turned on, lighting the filament and closing the B battery circuit. With switch C in "off" position, the meter G is adjusted to zero using the coarse rheostat F and the fine rheostat E, then switch C is turned to "on" and with the variable resistance D, the meter deflection must be brought to the red line on its scale. Now switch C is turned back to "off" and if the needle is in exact zero position, the photoelectric cell is exposed to the lamp. The resulting deflection is read on the scale and transferred into ultraviolet units with the help of a calibration chart. One must observe that the diaphragm through which the exposure of the photoelectric cell takes place is always open to the same degree.

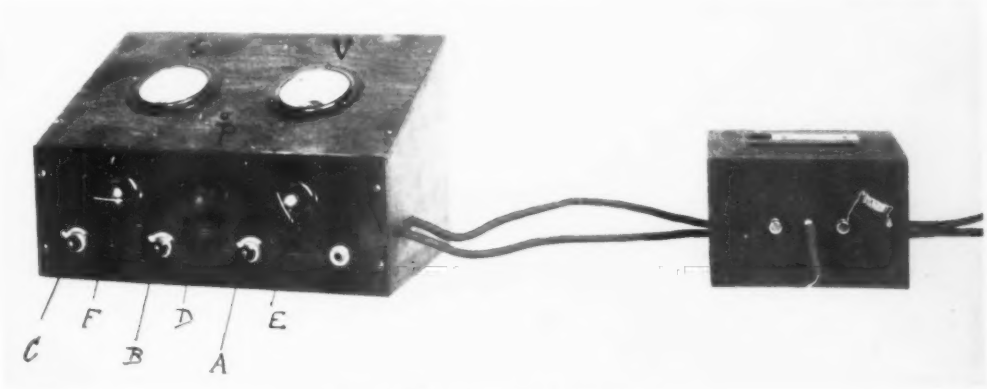

FIG. 7. The measuring apparatus.

* The details of this work will be published in another article.

SUMMARY

1. A measuring apparatus for ultraviolet radiation between 3200 and 2400 Angströms with a maximum sensitivity at about 2800 Angströms is described. It consists of a cadmium photoelectric cell in a uviol glass bulb connected to an amplification device in order to permit the use of an ordinary switchboard galvanometer.

2. The scale of the recording instrument can be calibrated in ultraviolet units or medium erythema dose of normal adult human skin.

In closing, the authors wish to acknowledge their appreciation to Professor H. M. Randall, Director of the Department of Physics, for his interest in this work and for the use of the facilities in his laboratory.

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RADIOSENSITIVENESS OF MALIGNANT TISSUE AND ITS BIOLOGICAL SIGNIFICANCE*

BY M. J. SITTENFIELD, M.D.

NEW YORK CITY

IN the attempt to arrive at a better understanding of the biological effects of radium in cancer we have come to an important milestone where it becomes necessary to review or correlate our experiences within the past fifteen years, and furthermore to submit them to a severe and critical analysis. Right at the outset a complex situation confronts us which requires an organized effort to review what has been accomplished, and also to formulate problems for the immediate future, since some writers claim extraordinarily favorable results in malignant diseases while others report equally unfavorable ones.

For the proper appraisal of these diverse opinions it may serve our purpose best to omit the clinical side of the question and discuss it from the biological standpoint only. To do this it is perhaps worth while to digress for a moment in order to postulate under separate headings the number and variety of factors which enter into this complex framework.

1. Intensity of the beam of radiation.
2. Quality and quantity of different wave lengths.
3. Amount and character of filtration.
4. Duration of exposure.
5. Area to be irradiated, whether superficial or deep.
6. Radiosensitivity of the component elements which make up the tumor.

Not to becloud the issue at this time, it may be more opportune to disregard all of these subdivisions and take for our consideration the varying degrees of radiosensitivity of the different elements which constitute the new-growth. For such a survey it becomes immediately obvious that the biological reaction of

* Read at the Twelfth Annual Meeting, AMERICAN RADIUM SOCIETY, Washington, D. C., May 16–17, 1927.

any one element of the tumor cannot be calculated with mathematical precision, inasmuch as we are far from the point of being able to designate a definite relationship between a certain dose of radium and its corresponding biological effect. Anyone conversant with the subject, however, realizes at once that there exist as many biological variations between the tissues of one tumor as there are differences in a tumor in one individual and a tumor of the very same type in another individual. In other words, there is much to support the view that it is impossible to ascribe to radium a generalized and definite selective action upon the various cellular types of tissue.

There are, however, fundamentals that have been observed experimentally and clinically regarding the biological action of the rays, irrespective of the immediate practical value of the knowledge gained. It is commonly felt and pretty well accepted that embryonal cells, lymphoid cells and cells of a highly specialized type are more selectively affected by radium than are the cells of the adult type. So, too, there is abundant evidence that the cells of the skin are more susceptible to a given dose of soft rays than they would be to the same amount of hard rays. According to the estimation of very able physicists, the wave length of the rays employed is of the utmost significance. By actual experimentation they show that wave lengths of 0.4 Angström units require about one-third the dose to produce the identical biological effect upon the skin as the shorter wave lengths of 0.16 Å. Again, some cells respond better to a larger and more massive dose of radium applied over a short period of time, than they do to a small dose applied over a longer period of time. Moreover, it is especially noteworthy that there are very striking variations in the latent period of different tissues when exposed to radium; the spleen, for instance, has a latent period of a few hours only, while radium applied to the skin produces its maximum effect after several weeks. Lastly cells, as a general rule, when in active state of division are more sensitive to radiation than they are at the time of the resting phase.

These brief outlines will help to explain the various phases of biological reaction to be considered in the discussion of the effects of radium. In the first place, for the orderly disposition of this question, it does not interest us greatly at this time to dwell upon the different transformations concerned in the cytological changes within the cell itself. Suffice it to place the primary and principal burden upon the nucleus of the cell; especially is this true at the time when the cell functions at its maximum. According to our former conception the greatest radiosensitiveness in a cell occurs not only at the time of its most active mitotic division, but also at the time of its slowest multiplication. In accordance with the greater effect of radium upon less differentiated and more actively dividing tissues, it would follow the regular order that embryonal tissues ought to be more sensitive than adult tissue, and this is actually the case. In this connection a new controversy has arisen,—and perhaps it will be in an increasing measure a stimulus to further progress. Bergonié and Tribondeau's old law stated that the more actively cells were undergoing mitosis, the more sensitive they were to the action of radium. As a result of recent studies the newer school of Strangeway and his collaborators, also Mottram, Scott, Russ and others feel that while this may in part be correct it does not cover the whole of the biologic law in the interpretation of radiosensitiveness. They emphasize that the activity of the *metabolism* runs parallel with its radiosensitiveness. From data obtained they claim that identical skin areas in different individuals react differently to a certain dose of radium, also that a tissue in a state of hyperemia is more sensitive to radiation than one in a state of ischemia. For example, raising the temperature of a tissue 8 to 10°F. increases the speed of reaction 2 to 3 times. While hyperemia does not increase the percentage of mitosis, it does enhance, however, the intensity of the metabolism. The same may be true of leucocytes which are very radiosensitive *in vivo*, where they exhibit a very active metabolism. In contrast to this, they become resistant *in vitro* because they adapt themselves to new surroundings.

Radiosensitiveness in hyperthyroid patients according to these authors might be attributed to the increased metabolic rate in these individuals.

That two cancers of the same morphological appearance react differently in two individuals can very well be explained by differences in individual metabolism. This too applies to the different radiosensitivity at different sites, because of differences in local metabolism. Therefore it becomes immediately obvious that the metabolic rate of different tissues varies. A cell which is functioning specifically is more radiosensitive than one at rest, since its metabolic rate is greater. These same observers claim that a normal tissue on being irradiated responds with an inflammatory reaction and hence increases its metabolism, and for this reason normal tissue becomes more radiosensitive to a second irradiation. A tumor, on the other hand, when irradiated defends itself against this new condition produced in its environment by decreasing its metabolism and so becomes less radiosensitive. Russ states even that animal tumors which have received a dose just short of lethal when inoculated into animals become resistant to further irradiation, and this resistance becomes more marked with each successive generation irradiated. Radiosensitiveness then depends not so much upon the histological structure of a tissue as it does upon its functional activity. The very fact that two tumors identical in histological structure react differently to radium shows that the metabolism of the neoplastic tissue is variable and not fixed by its structural type. These same observers even go so far as to claim that there is no such thing as selective action of rays upon the various morphological types of tissue; even if the biological behavior be uniform and constant, the difference in the response depends upon the metabolic rate of the tissue. There are certain implications in this relationship that may very easily be misleading and with which I do not find myself in complete accord. It was thought expedient, therefore, to attempt to check these observations and see whether there are common principles that hold true for them all. My own personal work within the past few months brought out that twice the lethal dose of radiation commonly employed to kill a twelve day chick embryo in the egg failed to inhibit the growth and proliferation in tissue culture of the explanted heart from the dead embryo. Notwithstanding that the embryo had succumbed one hour after irradiation, the embryo heart grew fairly well in the first implantation, although it showed a decided slowing of growth in the second transplant. Here the growth became scanty with many degenerated cells and much vacuolation, and the heart finally ceased to grow after the third generation, or seventy-two to ninety-six hours after the irradiation. This is completely in line with other observations that although the embryo as a whole shows great sensitiveness to irradiation, the individual embryonal tissues are but slightly sensitive to the primary action of the ray. The heart from the dead chick embryo when grown *in vitro* in tissue culture had its rhythmic contractions restored and could be carried through three generations. The result of these experiments would make it appear difficult to maintain the importance of the metabolic rate. We cannot escape the inference that the intense energy of the heart muscle with its powerful muscular contractions would cause an exceedingly high metabolic activity, and for this reason the embyo chick heart ought to be particularly radiosensitive. Despite this, of all the tissues tested from the dead embryo, the heart muscle grew best of all. Taking it all in all, the impression gained from this experiment would indicate, for the most part, that mitotic activity and increased metabolism do not completely explain radiosensitiveness.

There is, however, a general consensus of opinion that the resting nucleus is much more resistant to irradiation than the nucleus during mitotic activity, and also that during the period of metaphase the cell is especially radiosensitive. To continue further on this phase of the question would lead us into a very lengthy discussion which eventually would fail to get us anywhere.

Aside from the significance of active mitosis and cellular metabolism, the vas-

cularity of the tumor or its lack of blood supply,—the preponderance of cellular tissue, or the abundance of fibrous structure, all of these factors play their rôle in determining the degree of radiosensitiveness of a given tumor. Oxidation and reduction processes have only recently been taken up for investigation in this connection, and promise to be of great interest. The newer work of Hopkins and his coworkers point to an oxygen reductant substance in all tissues, inasmuch as the oxygen of the tissue is reduced by this substance belonging to the sulph-hydryl system, consisting of cystin and glutamic acid and known as glutathione. Normally glutathione is present in practically all tissues, chiefly however, in the liver. It is found in extraordinarily large quantities in the malignant neoplasm at the expense of being greatly diminished in all the other organs. Equally interesting is the admirable work of Cramer, Cori, Hawkins and others who found that insulin, a constituent of all normal tissue, is absent in malignant new-growths.

This perhaps links up with the studies of Warburg previously discussed here, that tumor tissue is able to maintain itself practically without oxidation. Its metabolism is carried on chiefly by increased glycolysis, and differs from the normal glycogen metabolism in other tissues, in that it shows increased amounts of lactic acid formation, 10 to 50 times as much as in normal tissue.

Another phase of the problem, the importance of which has not been sufficiently appreciated in connection with radiosensitiveness, is that of secondary radiation. At this point it seems fit that we know something more about secondary radiations in the tissues themselves, and this brings us to the important part played by the heavy metals. Only lately has the employment of heavy metals to excite secondary radiations come into its own. At first sight this combination seems to insure prospects of success, though everyone is familiar with the failure that met the attempts to make use of selenium, copper, gold, arsenic, iodine, etc., until now new interest has been awakened in this field by the use of colloidal lead. I do not wish to be held to strict accountability in projecting my own view into this problem. Blair Bell and his school claim that colloidal lead injected intravenously seems to have a special affinity for embryonal and malignant tissues. If it is true that lead is stored up in the tumor tissue itself, then the presence of lead in the tumor, aside from its destructive effect behaves as a foreign body which essentially induces an inflammatory reaction. This in turn tends to raise the metabolic activity of the tumor cells, and in this state of heightened metabolism plus the active mitosis inherent in malignant tissue, probably renders the neoplasm more radiosensitive. Perhaps the reason for our former failures could be ascribed to the difficulties experienced in binding these heavy metals within the tumor. At any rate, this field of experimentation seems to offer fair prospects of success, first as a biochemical agent, altering their electrolytic relationship, and secondly, biophysically, in increasing secondary radiation. It is not my province to go into details of the biophysical and biochemical essentials of the problem although they are apparently not unrelated.

In connection with this, a few words may be said upon the behavior of colloids in irradiation. Investigations by colloid chemists upon the stability of colloidal solutions reveal that the positive colloids in the irradiated solution are precipitated, though the negative ones are little affected. This is explained on the basis that beta rays carry negative charges, so naturally they would react with the positive colloids. Of the electronegative colloids such as gold, molybdenum or vanadium, none were influenced by irradiation. By the alteration of the colloidal equilibrium of the cell in irradiated tissue, it follows that autolysis occurs to a very much greater extent than in unirradiated tissue. We cannot escape the inference, therefore, that the intracellular enzymes are activated. Interference with the colloidal equilibrium of the cell would tend to destroy its functions wholly or in part, and the normal resistance of the cell would be thereby brought to a lower level, and in this state the cell perhaps becomes more radiosensitive.

It is obvious that unless we have a

better conception of the biological reactions going on when rays of radium come in contact with the surface and interior of the cell, we are under a decided disadvantage. The problems of radiosensitiveness are complex and need to be unravelled one by one before we can hope to have the faintest idea of what is taking place in a tissue. We must realize that only through an exact knowledge of the biophysical and biochemical interrelations in a cell can we hope to raise the study of the biological reactions of radium upon cancer to the level of an exact science. The present situation regarding radiosensitiveness embraces so many different processes that each one of them must be studied in detail. For our immediate needs it is absolutely essential to formulate these problems in such a manner as to enable us to interpret accurately the action of radium upon neoplastic tissue. Therefore the co-operation of biologist, biochemist, clinician, physiologist and pathologist must be so adjusted as to bring about uniform and comprehensive co-ordination.

DISCUSSION

DR. HENRY J. ULLMANN, Santa Barbara, Calif. The paper covered so much ground that I feel it extremely difficult to discuss it as a whole, but the one point to which I wish to invite attention is the sensitization of tumors, which have been treated by lead, to irradiation and whether this sensitization is necessarily due to secondary radiation from the lead or to a summation of injuries, as suggested by Dr. Wood. The thought occurs that if it is due to the secondary radiation the tissues should immediately become sensitive after the lead injection. Lead remains in the blood only one and one-half hours before being taken up by the tissues. As a matter of fact, the tumors show little sensitivity to radiation immediately following the use of lead, but some weeks afterward they become extremely sensitive to radiation. Further, the amount of lead is so small that it cannot be seen passing through a vein by the fluoroscope during an injection, and when we realize that the largest part of the 200 to 300 mg. injected is stored in the bones, there is not much left in the tumor to account for the response to irradiation. Therefore, the theory of Blair Bell on this question does not seem tenable. Our post mortem examinations have frequently shown less lead in the tumors than in the liver and other parts of the body. I do not include the bones, for it is well known that lead is taken up by the bones and held there. The liver, of all the organs, takes up the largest amount. Some workers have reported that lead is distributed throughout the body in proportion to the vascularity of the part. That may account for the vascular tumors being more sensitive, but I do not believe that these tumors pick out and store lead to the exclusion of other portions of the body, with the exception of the bones.

DR. EDWIN C. ERNST, St. Louis, Mo. Recently we have been studying cases of melanocarcinoma, observing the effect of simple roentgen-ray irradiations, massive filtered applications, and the combination of roentgen rays or radium subsequently followed by surgery, with the result that valuable practical knowledge has been gained thereby.

One case particularly brought to our attention the importance of studying atrophic and hyalinization changes of irradiated cells. These tissue changes have been given due consideration by many observers, but I believe the general chemical phenomena are of the greatest interest and importance in the therapy of cancer. This particular case was referred to me by Dr. A. E. Ewing after several recurrences of melanoma in the upper eyelid had followed operative procedures. Subsequent to each operation, the lesions promptly recurred until two-thirds of the eyelid was involved. In addition to an immediate recurrence of the lesion, there was also evidence of glandular enlargement of the structures anterior to the ear on the same side. Prior to radiation therapy, the entire eyelid was covered with a melanotic growth which extended one-fourth of an inch or more below its lower margins as a tumor projection. The superficial roentgen-ray dosage employed was a suberythematous application with a maximum of 1 mm. of aluminum filtration. We attempted not to injure the very small amount of normal mucous membrane remaining under the eyelid and the change which took place was most interesting in that only a few small tumor areas could be visualized. We advised that these should be removed by operation and for a period of six months the infiltration has not returned. The mucous membrane remains normal.

On histological study of the effect of irradiation, the entire irradiated tumor, including the glands, was found surrounded by an unusual hyalinization zone.

At the Barnard Free Skin and Cancer Hospital, Drs. Burrows, Jorstad and I have shown that coal tar and other lipoid solvents apparently act by dissolving and removing lipoid-like substances from the tissues. This substance

has been called ergusia, or vitamin A, because of the fact that experimental observations have shown such a close relationship of vitamin A and this normal lipoid constituent of cells and intracellular substances. Primarily, the tissue changes produced by roentgen rays or radium are: (1) Swelling of cells and intracellular fibrils; (2) loss of staining power of the nucleus; (3) sclerosis of epithelial layers, and (4) hyalinization of connective tissue.

It is possible, then, to show that the action of irradiation is primarily the acceleration of the normal stimulatory substances of the body vitamin; secondarily, the separation of the lipoid constituents from the protein constituents. Such action not only destroys the cancer cells but separates and allows to escape the lipoid constituents of the surrounding normal tissues which are necessary for the subsequent growth of the cancer cells which remain.

It has thus been possible to deduce the action of irradiation for growth of cells as well as the body. Working with tissue cultures, Dr. Burrows has shown that the body cells cannot grow in any media unless they are supplied with lipoid constituents of other cells and tissues, and when the lipoid substance necessary for the growth of cells is removed from other cells and tissues, these other cells and tissues suffer the typical hyaline change through the action of irradiation. The hyalinizations are produced by small effective homogeneous doses of roentgen rays or radium, and there appear areas of round cell infiltrations. When produced by larger doses the round cells fail. These sclerotic areas and hyalinizations and round cell infiltration processes are quite identical with those seen in other precancerous lesions, for example, chronic cystic mastitis. In our specimens the hyalinization was most pronounced in the surrounding structures of the large and small tumors that were removed.

I wish to leave this one thought, that the atrophy and hyalinization of the tissue have been given due consideration by many observers, but the general chemical phenomena should be and are of the greatest interest in helping us to more clearly visualize the cancer problem, and thus be of value from a practical stand-point in selecting the most effective irradiation dosage.

Dr. Robert B. Greenough, Boston. I think we are all quite ready to admit that this is a complex question, and as I see it, the biological work is complex for the reason that the experimental method, while it may be applied, is not applied under exactly the same conditions as in the living organism. If we attempt to apply the lessons learned in mouse experiments to the human being we find that they do not exactly correspond. When Dr. Sittenfield attempts to measure the exact dose necessary to destroy the tissue in the human being, we find there is a discrepancy.

One of the most important points to be determined is whether different wave lengths may be considered to produce different activities in the way of change of function of cells. Up to the present time the evidence has been that the different wave lengths give us only different degrees of penetration, and the penetration of the tissues is what determines the different results obtained. As our roentgen rays closer and closer approximate the quality of the gamma rays of radium, the results clinically approach those of treatment with radium. I feel that from a purely clinical point of view it is at present extremely difficult to determine that one particular tissue, or one particular type of tumor, is more sensitive to one length of wave than to another. It seems to me that most of the differences we have been able to determine have been those connected solely with the varying degrees of penetration.

Apart from this, I would like to bring to mind some ideas in regard to radium irradiation that have made some impression upon me. That is, the effect of irradiation on tumor tissue in the way of the gradual return of the cells towards the normal in the two respects by which we judge of the malignancy of cancer cells in our efforts now to classify the degree of malignancy; namely, the diminished rapidity of division of the cells and increase in their normal differentiation for function. You are all familiar with the work that has been done in classifying the different tumors in regard to malignancy, and the main feature of all these efforts is to determine to what extent the cancer cell is abnormal in these two respects, (1) the increase of rapidity in growth, and (2) the loss of function. According to Alter, the result of irradiation short of destruction of cancer cells diminishes their rapidity of growth and along with that develops more of their normal functions, as evidenced by the development of a secretion, or keratin, or whatever the content of the cell may be. This is very interesting, because it opens up the possibility of the cancer cell being brought back into the path of righteousness, rather than that the cell must suffer capital punishment in order that the patient may live.

Dr. H. H. Bowing, Rochester, Minn. In conversation with Dr. Greenough this morning regarding the observations of Dr. Alter on irradiated malignant tissue, I stated that they are very important to the radiologist. As you know, the chief effort has been to destroy the malignant growth. In ancient days a hot rod

or hot oil was used. Those methods have given way to the surgeon's knife, heat (more nicely controlled, however), and irradiation. The treatment is based on the fact that cancer is being destroyed. There seems to be another process for freeing the patient of neoplastic disease. Now and then cases respond promptly to small irradiation doses. Then, there is the case treated with the small broken-dose method, in which the tumor will gradually diminish in size, without ulceration, and no gross evidence of destruction. There must be an explanation for this observation. I think it is well that we should have some therapeutic rationale even though we may have to change our ideas from time to time. It should help in outlining the irradiation technique to be employed in a given case. At least we should form some idea of what is going on in the treatment field. The observations of Drs. MacCarty, Broders and Alter furnish some idea of what is happening in the tissues following a lethal and a probably sublethal dose of irradiation to the malignant cell. It is important to study the changes in the nucleus and the cytoplasm of the malignant cell, as well as the tissue changes as a whole, for we know full well that the malignant process has possibilities of resistance and that the individual has possibilities for diminishing the activity of the carcinomatous process and that as yet they defy analysis. In other words, a cancer resisting mechanism exists. What this is we do not know, but without it lesions will not heal. As you know, there are cases reported in the literature in which cancers have disappeared without treatment. Since Broders and MacCarty have shown that the life of the patient can be estimated by noting certain tissue changes it seems possible that these studies may lead to a better understanding of this cancer resisting mechanism and finally to a better understanding of what treatment factors to employ. I would prefer to drive the cancer through these natural processes rather than consider the treatment lethal or destructive. In other words, I would like to apply a biologic dose which would hasten or accelerate normal tissue changes and thus help the patient fight the disease. From a radiation standpoint we should look on patients with malignant disease as having more power within themselves to heal the lesions than we can ever hope to produce.

Dr. SITTENFIELD (closing). The purpose of this review was not to relate all the complex factors which have engaged the attention of workers of different countries, but to impress upon you the importance of the biological reaction or response on the part of the cells or tissues themselves to radium. I wished to bring to your attention that the cancer is the important factor, and not the radium or its biological reaction.

Cancer is a reaction on the part of the organism to an abnormal stimulant. By destroying the cancer cell we do not destroy the tendency of the host to the abnormal reaction, and this is the phase of the subject that deserves our consideration. The reaction is simply a response to any injury. Our problem is to solve the cause of this injury and if possible, eradicate it. I agree with Dr. Ullmann that the sensitiveness of the cell is not due to any one factor alone, but is a result of a summation of the injuries to the cell. It is our purpose to learn a little more of the biological behavior of the cancer cell, and of the cause of its malignancy, when it starts.

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Thirteenth Annual Meeting: Minneapolis, Minn., June 11–12, 1928.

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EDITORIAL

THE EARLY DEVELOPMENT OF ROENTGENOLOGY

IT is now only thirty-two years since the discovery of the roentgen ray, a time far too brief to enable us to view the subject in anything approaching a true historical perspective. The continual entry of new members into the ranks of roentgenologists makes it seem advisable, however, to recall from time to time the important events in the discovery and early development of the roentgen ray.

The year 1895, in November of which Wilhelm Conrad Roentgen discovered what he then called the "*x*-ray" is well within the memory of many of us. It came as one of the dramatic concluding events of that tremendous nineteenth century which was more important in its contributions to scientific knowledge than the eighteen hundred years that preceded it. It will be known to future historians as the century in which scientific medicine had its birth.

Among all the advances and discoveries of the century, that of the roentgen ray perhaps owes most to the long-continued scientific work along many different lines that preceded its discovery for almost a hundred years. The whole story is an excellent illustration of the way in which scientific inquiry, which seems at the time to have no practical bearing nor any relation to the broad field of science may finally work out into far-reaching practical results and may even come to be recognized as a fundamental scientific achievement upon which depends tremendous subsequent development.

If we were to gather up all the threads that were finally drawn together to render the discovery of the *x*-ray possible we would need to travel far afield. It would be necessary for us to go back to Abbé Nollet and his "electrical egg" experiments in the middle of the eighteenth century, and back further still to Otto von Guericke who in 1650 invented the air pump. We should need to follow the development of the air pump and to pay special attention to the invention of the mercury pump by that versatile genius Swedenborg in 1722, and its perfection by Heinrich Geissler in 1858 and Hermann Sprengel in 1865. The work of Michael Faraday along several different lines would demand our attention. We would recall that in 1831 he discovered electromagnetic induction and devised the induction coil, and that he experimented with vacuum tubes and described the unilluminated space around the cathode, subsequently named the "dark space of Faraday." From Faraday it would be natural to pass on to three men whose main work was accomplished during the midportion of the nineteenth century and who did much work together—Julius Plücker, Heinrich Geissler and Johann Hittorf.

Geissler has already been mentioned as the inventor of a mercury pump which was a great improvement over anything previously used to produce a vacuum. He settled at Bonn in 1854 and soon became well known for his skill in devising and making physical and chemical apparatus. It was his skill as a glass blower that enabled him to make the tubes which Plücker and Hittorf used. Julius Plücker, working at the University of Bonn, was the first to leave any record of what are now known as cathode rays, as he was the first to work with glass tubes with anything like what is now known as a high vacuum. J. W. Hittorf was a pupil of Plücker's and greatly extended the knowledge of the phenomena that take place when a high tension current is passed through a vacuum tube. He made the classical observation that a solid body placed between a pointed cathode and the walls of the tube casts a well-defined shadow.

Immediately following the work of Plücker and Hittorf, a great advance was made by the work of William Crookes in

England. That the death of Sir William Crookes occurred so late as 1919 is another indication of the youth of roentgenology. This man who made some of the most important of the preliminary physical investigations which led to the discovery of the roentgen ray lived in our own time. It was his experiments on the electric discharge through rarefied gases that led to his theory that a cathode in a vacuum gives rise to a stream of material particles which are shot off at right angles from the surface of the cathode and which cause phosphorescence in the glass of the tube. He also showed that the stream of discharge could be deflected by a magnet. Further work of his own supplemented by work of Plücker, J. J. Thomson and Jean Perrin proved beyond doubt that the cathode stream is made up of rapidly moving particles carrying a negative electric charge.

To follow the development of our knowledge of the cathode rays we must next return to the University of Bonn where Plücker had first recognized their existence in 1859. Heinrich Rudolf Hertz was a brilliant pupil of Helmholtz; he was born in 1857 and died in 1894 at the age of thirty-seven. In spite of his early death his work was epochal. His great discovery of the progressive propagation of electromagnetic force through space in confirmation of the brilliant theories of Clerk Maxwell which were based upon pure mathematical calculations, his measurement of the length and velocity of electromagnetic waves and his demonstration of the transverse nature of their vibrations is the foundation of the wireless telegraph and the radio. In 1889 he became professor of physics in the University of Bonn and continued his researches on the discharge of electricity in rarefied gases. Up to that time it was thought that all solids were opaque to the cathode rays, but Hertz showed that there was an appreciable phosphorescence behind a piece of gold leaf or aluminum and that the phosphorescence moved when a magnet was brought near. This was his last work for he died in 1894 after a long illness. In 1892, P. E. A. Lenard, a pupil of Hertz, succeeded in showing that the cathode rays could pass through an aluminum window to the outside world.

The stage was then set for the discovery of the *x*-ray. The wonder is that Crookes or the brilliant Hertz did not discover its existence.

The story of the almost accidental way in which William Conrad Roentgen on November 8, 1895, in the physical laboratory at the University of Würzburg, finally recognized the existence of this hitherto unsuspected force is familiar to all. Today it does not seem so remarkable that Roentgen should have recognized the fact that he was dealing with some new phenomenon when he observed the fluorescence of platinobariumcyanide when a current was passed through a Hittorf tube covered with black paper impervious to light. The mark of the thorough-going scientific man of real vision is shown in the manner in which he investigated the new force. On December 28, 1895, he presented a paper before the Würzburg Physico-Medical Society entitled "A New Kind of Rays" which in accuracy and completeness has been rarely surpassed in original reports of scientific discoveries. In that first paper he set down the properties of the *x*-rays, and his conclusions have been verified in almost every particular.

Physicists everywhere were in a surprisingly short time investigating the nature of the new rays. Roentgen himself was inclined to the theory that the rays were due to longitudinal vibrations in the ether. Professor Sylvanus P. Thompson, the first president of the British Röntgen Society, writing in the *Archives of the Roentgen Ray* in 1897 reviewed the theories which were advanced at that time: (1) The corpuscular theory which attributed the *x*-rays to a species of hyperatomic matter projected with great velocity and capable of passing through the pores of ordinary solids; (2) The transverse wave theory which held that the *x*-rays are simply a transverse vibration in the ether like ordinary and ultraviolet light and differ only in having an excessively short wave length; (3) The so-called "pulse" theory of Sir George Stokes which held that *x*-rays, although consisting of transverse vibrations, differed from ordinary

light in that each wave is made up of perhaps only one or two wavelets instead of a regular train of half a million or more wavelets.

Prof. J. J. Thomson of Cambridge and Sir William Crookes were inclined to the corpuscular theory, but as early as 1896 Sir Oliver Lodge had described the transverse vibration theory as "the one surviving hypothesis." Time has proven the correctness of this theory and the unknown ray has taken its place in a continuous spectrum extending from the long Hertzian rays of wireless through infra-red, ordinary light, ultraviolet, *x*-rays, gamma rays, and the lately discovered cosmic ray.

J. J. Thomson in the *London Electrician* of February 7, 1896, reported his discovery of the ionizing property of *x*-rays. He showed that they had the power of dissipating the charge of a perfectly insulated electrified body. Among the early workers on the physics of the *x*-rays, in addition to those already named, who confirmed the findings of Roentgen were Jean Perrin in France, A. Righi in Italy, and Elihu Thomson in the United States.

Almost immediately upon Roentgen's announcement of the properties of the new rays, their possibilities in medicine and surgery began to be investigated. The necessity for more powerful generating apparatus and for hardier tubes was at once apparent. Roentgen had performed his experiments with a small induction coil and mechanical interrupter and with Hittorf tubes in which the cathode stream was thrown directly upon the glass wall. In the early years there was much argument as to the relative merits of the induction coil and the influence or static machine. As late as August, 1899, in an editorial in the *Archives of the Roentgen Ray*, the statement was made that "the influence machine versus the coil is a constant theme for controversy." The partisans of the static machine contended that there was much less liability to *x*-ray burns from this type of generator than from the coil.

There were two main types of static machines in use—the Holtz machine used mostly in the United States, and the Wimshurst machine used in England and France. The static machine was used scarcely at all in Germany. Williams describes a static machine of the Holtz type constructed under the direction of Rollins which had four revolving plate glass plates 6 feet in diameter and four fixed plates 6 feet 4 inches in diameter. The early textbooks, notably those by David Walsh, Williams, and Pusey and Caldwell, give much space to the construction, care and operation of static machines. After 1900 the static machine became less and less common and the induction coil became the usual source of the high tension current. The high frequency coils designed by Tesla had a vogue for a time but coils of the Ruhmkorff type soon displaced all others. The most troublesome adjunct of the induction coil was the interrupter which in the early years was of the vibrating or, more rarely, of the rotating type. Such interrupters worked satisfactorily with currents of small amperage but when the demand became insistent for stronger currents necessity forced the invention of more efficient interrupters. Various types of mercury interrupters based upon different mechanical principles were used. There was the mercury plunger, the mercury dip, and different designs of mercury jet interrupters. The most efficient interrupter, as well as the least troublesome and most durable was the electrolytic. William Spottiswoode in the *Proceedings of the Royal Society* for 1876–77 had described the principle of electrolytic interruption, but Prof. A. Wehnelt of Charlottenburg was the first to apply it to the induction coil in 1899. A. W. Crane of Kalamazoo devised a very efficient modification of the Wehnelt interrupter, and in 1899 Eugene Caldwell invented an electrolytic interrupter somewhat different in principle from the Wehnelt which was widely used both in this country and in Europe. It was known as the Caldwell-Simon interrupter because Dr. Simon of Berlin described it independently about the same time as Caldwell.

There was then very little change or improvement in the apparatus for producing the high tension current until 1908 when H. Clyde Snook of Philadelphia invented the so-called "interrupterless" machine. He read his paper describing

the new apparatus before the Fourth International Congress at Amsterdam in 1908. It has remained the standard high tension apparatus to the present day. It must be looked upon as one of the most important contributions that has ever been made to the advancement of roentgenology. It not only eliminated the troublesome interrupter but for the first time made the alternating current directly available for the production of *x*-rays.

It was necessary that the increase in output of coils and transformers should find a corresponding improvement in *x*-ray tubes. The first important advance in their construction was made by Prof. Herbert Jackson of King's College, London. In 1896 he introduced what has ever since been called the "focus" tube. Like many great inventions it seems now a very obvious and almost inevitable advance in tube construction, but when it is remembered that in 1896 the theory of Sir Wm. Crookes of the material nature of the cathode stream was not by any means universally accepted, it will be realized that it required real insight to recognize the value of placing a metal target within the Crookes tube upon which the cathode stream could impinge and there produce the *x*-ray. As soon as platinum target tubes came into general use improvements in their construction followed rapidly.

The need for some method to regulate the vacuum was recognized very early. One of the most widely used in early days was the osmo regulator of Villard which had a platinum wire sealed into the tube which could be heated by a flame. The hydrogen from the flame passed through the spongy platinum and lowered the vacuum. Another early type of tube devised by Sayen and known as the Queen-Sayen tube depended upon an accessory tube in which was placed a chemical which gave off vapor when heated. A spark passed through the accessory tube served to heat the chemical which gave off vapor which was in turn reabsorbed when the chemical became cool again. This was the first so-called self-regulating tube, which had many modifications as the years passed.

Copper was used as a backing for the target in order that the heat might be rapidly conducted away. Water-cooled and air-cooled tubes were devised. As early as 1896, Dr. Rollins in Boston devised a tube that could be cooled by air or water. The platinum was finally replaced by tungsten because of the higher fusing point of the latter. Then in 1913 Dr. W. D. Coolidge finally designed a hot cathode tube, and improvements were made in methods of exhausting the air from the bulbs that made it possible to produce a perfect vacuum. It was no longer necessary to have gas in the tube which could be broken up to produce the ions for the cathode stream. The ions could be obtained directly from heated metal.

The most widely used method in the early days for *x*-ray examinations was the fluoroscopic. The principle had been known from the time of the discovery of the *x*-ray, but it was Salvioni in Perugia, Italy, and Thomas Edison in the United States who recommended the closed fluoroscope. Salvioni used the platinobariumcyanide screen, while Edison recommended a screen of calcium tungstate.

The roentgenographic work of the early years was nearly all done on glass plates coated on one side with photographic emulsion. The average exposure, even in 1903 when Pusey and Caldwell's textbook was published was stated by them as follows: "In ordinary practice a majority of workers find it necessary to expose for the hip-joint five to fifteen minutes, for the shoulder five minutes, for the hand one-half to one minute, for the head one to six minutes." These are the exposures necessary without intensifying screens. Probably the first man to use intensifying screens was Michael Pupin of New York who reported on their use in *Electricity* on February 12, 1896. Among early users of intensifying screens were Campbell Swinton in England and Max Levy in Germany. In the volume of the *Fortschritte auf dem Gebiete der Röntgenstrahlen* for 1899–1900 Rieder and Rosenthal have an article on instantaneous roentgenography by the use of intensifying screens. Max Levy was probably the first to use plates coated on both sides and double intensifying screens of calcium tungstate.

An important early observation that resulted in improvement in roentgenography was that of Theodore Guilloz on the production of secondary rays within the body. His paper was published in the *Comptes rendus de l'Académie des sciences* in 1900 and he recommended therein a suitable diaphragm to minimize the effect of secondary radiation upon the plate. Albers-Schönberg improved upon this by using the cone or cylinder as a compressor for making roentgenograms of the kidneys. In 1903, A. Béclère made a further improvement by using a rubber bag beneath the cylinder or cone.

The value of the stereoscopic principle in roentgenography was recognized very early. Elihu Thomson in this country recommended the stereoscopic method in 1896 and James Mackenzie-Davidson adapted the Wheatstone stereoscope to this use in 1898.

Among the very earliest uses of the *x*-ray in medicine and surgery was its employment for the localization of foreign bodies. Among the earliest articles on the subject was one by John Trowbridge on "Triangulation by Means of the Cathode Photography" published in *Silliman's Journal of Science* in 1896. Rémy and Contremoulins early in 189- described an apparatus to the Academy of Medicine of Paris for location of projectiles. In May, 189-, Charles Lester Leonard described a method of triangulation in the *Annals of Ophthalmology*, and in August of the same year Max Levy and Thumim published an article in the *Deutsche med. Wochenschrift* on a method of precise localization by use of one radiograph and mathematical calculations. Then in October, 189-, James Mackenzie-Davidson described his classical cross-string method of localization. Since that time there have been literally hundreds of methods described for the localization of foreign bodies.

Along with the location of foreign bodies went attempts to demonstrate the presence of renal calculi. John MacIntyre reported a case in the *Lancet* of July 11, 1896, of a patient who had been previously operated upon for renal calculus; by a twelve-minute exposure a shadow of a large calculus was shown. The patient was operated upon and the calculus found and removed. Charles Lester Leonard in the *Archives of the Roentgen Ray* for May, 1899, in an article entitled "The Detection of Calculi by the Roentgen Ray" reports 17 cases of renal stone diagnosed by roentgen examination. Eleven of them had been operated upon and the diagnosis confirmed in all. There were negative diagnoses in 5 cases confirmed by exploratory operation.

In 1901 Geza-von-Illyes made the first report of the use of opaque catheters to demonstrate the course of the ureters, and in January, 1906, Woelker and Lichtemberg published the first report of pyelography after injection of collargol.*

A. C. CHRISTIE

* A further account of the application of the roentgen ray to medicine will be published in the next issue of the Journal.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY & RADIUM THERAPY *visiting New York City are invited to make the office of the publishers (Paul B. Hoeber, Inc., 76 Fifth Avenue, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. John T. Murphy, 421 Michigan Ave., Toledo, Ohio.
Twenty-ninth annual meeting, Kansas City, Mo., Sept. 25–28, 1928.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Minneapolis, Minn., June 11–15, 1928.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. E. C. Samuel, New Orleans, La.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. O. J. Shore, 2033 Park Ave.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. E. Everett Rowell, 200 West 59th St.
Meets monthly on third Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. James M. Flynn, 282 Alexander St.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Annual meeting, Galveston, Texas, 1928.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Annual meeting Oct. 17, 1928.

British Empire

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.
Next annual meeting, Charlottetown, P. E. I., June 21–23, 1928.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHOSLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.
Next meeting with the Gesellschaft deutscher Naturforscher und Aerzte will be in Hamburg, September, 1928.

SUD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.
Next meeting September 27, 1928, in Hamburg.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S. G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1928.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Elektorowicz, 19 Hoza St., Warsaw.
Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. H. Scheuermann, Copenhagen
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

APROPOS OF EMPHYSEMATOUS BLEBS*

To the Editor:

In the January, 1928, issue of the *United States Veterans' Bureau Medical Bulletin*, Dr. G. E. Lentine of the U. S. Veterans' Hospital at Castle Point, N. Y., makes the claim that he has published the first photograph of what, very evidently, is an emphysematous bleb or bulla, though he calls it a "localized circumscribed unruptured pneumothorax." He is not the first to claim a connection between emphysematous blebs and annular shadows, for it is also made by Sigfrid Arnell in the *Acta radiologica*.

The earliest account of the gross appearance of the lung in these cases, that I am acquainted with, "is contained in Watson's Practice of Physic, that storehouse of information, to which but few turn in these days, where it is correctly described as a subpleural emphysema" (Miller). Watson refers to a still earlier case, the description of which I have failed to find.

In the issue of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY for May, 1926, I discussed the pathological conditions found in these cases and reported at length the necropsy protocol of a case which occurred in the practice of Dr. Kennon Dunham of Cincinnati. Dr. Dunham very kindly turned the material over to me and it formed the basis of the paper which, probably, was the first instance in which the necropsy findings were studied microscopically, by means of serial sections, and the point where the alveoli were ruptured illustrated by a photomicrograph.

Arnell's case occurred in February, 1927. Accompanying his paper he published

* The original work on Emphysematous Blebs was done under a grant from the National Tuberculosis Association.

roentgenograms which show, he says, that the annular shadows present were caused by emphysematous blebs that were demonstrated at the necropsy; a result I had presupposed in my paper quoted above, my supposition being based on the protocol of Dr. Dunham's case.

Arnell is mistaken, however, in saying that "perhaps this is the first case, in which the post-mortem examination has considered the roentgenological diagnosis of emphysema-blebs as the cause of annular shadows" for, had he read the protocol of Dr. Dunham's case carefully, he would have found that it *was* considered, and after events showed how the position of the air contained in the bleb could change its position with a changed position of the lung.

In the issue of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY for July, 1927 (the date of its acceptance being April 6, 1927), I still further elucidated the subject of "Emphysematous Blebs" and published a photograph of a bleb which antedated that of Dr. Lentine. Furthermore, I gave a detailed analysis of the bleb as shown by a medial section.

The same lung also contained other, and much smaller, blebs; one of these was imbedded and cut into serial sections; two of the illustrations accompanying my paper are photomicrographs from this series.

In both of my papers the distinction between a "bleb" and a "bulla" is discussed and photomicrographs of each condition accompany the papers.

Dr. Lentine's paper has one feature which makes it, to my mind, superior to that by Arnell; he shows a roentgenogram, taken during the life of the individual, of the lung on which the bleb was found at the necropsy.

The five papers* quoted below should be of assistance in solving some of the problems connected with those annular shadows which are often diagnosed as cavities or as small pneumothoraces.

WILLIAM SNOW MILLER, M.D.

* Arnell, S. Annular shadows in the lungs caused by subpleural emphysema. *Acta radiol.*, 1927, viii, 252.

Lentine, G. E. Photograph of pneumothorax on post mortem. *U. S. Veterans' Bureau Med. Bull.*, Jan., 1928, iv, 38.

Miller, W. S. A study of the human pleura: pulmonalis: its relation to the blebs and bullae of emphysema. AM. J. ROENTGENOL. & RAD. THERAPY, 1926, xv, 309.

Miller, W. S. A further study of emphysematous blebs. AM. J. ROENTGENOL. & RAD. THERAPY, 1927, xviii, 42.

Watson, Thomas. Principles and Practice of Physic. Revised, with additions, by D. Francis Condie: Philadelphia, 1851, 624.

POLISH SOCIETY OF RADIOLOGY

The radiologists of Poland have recently organized the "Polish Society of Radiology." The Society issues a monthly journal "Polski Przeglad Radiologiczny" (Polish Radiological Review). General meetings of the Society are held once a year. The first meeting was held in Warsaw on the 26th and 27th of November, 1927. The president of the Polish Society of Radiology is Dr. K. Mayer, Professor of the Poznan University, and the secretary is Dr. A. Elektorowicz, 19 Hoza St., Warsaw.

There is a Warsaw Section of the Polish Society of Radiology which meets once a month, except in the summertime. The chairman of the Section is Dr. B. Sabat, and the secretary Dr. B. Krynski, 11 Zielna St., Warsaw.

AMERICAN RADIUM SOCIETY

The American Radium Society will hold its next annual session at Minneapolis, Minn., on June 11 and 12, 1928. Hotel Radisson will be the headquarters of the Society.

Members desiring to contribute to the Minneapolis program should communicate as soon as possible with the chairman of the Program Committee, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo.

MEETING OF CATHOLIC HOSPITAL ASSOCIATION

The Catholic Hospital Association announces its Thirteenth Annual Convention to be held at Cincinnati, Ohio, June 18 to 23, 1928. The convention will be held in the Cincinnati Music Hall which affords good facilities for the general meetings, a separate hall for commercial exhibits and separate rooms for clinical exhibits and clinical demonstrations. In the clinics will be shown various phases and departments of hospital work completely equipped and in actual operation.

The co-operation and advice of members of the American Roentgen Ray Society are invited. An invitation is also extended to the members of the Society to participate in the clinics and demonstrations. Anyone who wishes to take part in the convention should correspond with Dr. John R. Hughes, general chairman, 131 11th St., Milwaukee, Wisconsin.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

APPARATUS FOR MAKING ROENTGENOGRAPHIC EXAMINATIONS OF THE HEAD

BY WILLIS F. MANGES, M.D.

PHILADELPHIA, PENNSYLVANIA

IT has always been my custom, and I believe the custom of most roentgenologists, to make roentgen-ray studies of the head with the patient in the prone posture, using a tube stand or tube-holding mechanism that required a great deal of very careful manipulation to get accurate centering of the tube with relation to the film, as well as centering of the head with relation to both. In fact, our centering efforts were not always successful. My own failure to get uniform results, the inconvenience as well as discomfort to the patient, the difficulty of persuading children to get on the table, and the excess of time required for the examination in any patient led me to desire a piece of apparatus that would permit of such studies with the patient sitting in a comfortable position, and with the tube constantly and mechanically placed so that the central ray would always fall on the center of the film, and permit of easy shift for stereoscopic films.

My ideas with regard to the design of the apparatus have been more or less crystallized for a number of years, and on more than one occasion I have discussed it with other roentgenologists and even approached some of the manufacturers of accessory equipment, but for some reason nothing was accomplished until during the past summer when I persuaded the M. H. Bresette X-Ray Company to take an interest in my device and to build at least one for me. After working with the original model for two months, I had them make two more. I now have the three in operation and could not get along without them. In addition to all kinds of work around the head, jaws, and neck, I find it is ideal for study of the shoulder and clavicle, and I have also used it to make roentgenograms of the chests of children.

This apparatus, as I use it, does not contain a Potter-Bucky diaphragm. It would be a very simple matter, of course, to have it made so that it would hold the diaphragm. I prefer head roentgenograms to be made with double screens and without the Potter-Bucky diaphragm for the same reasons that I do not use a diaphragm for chest work. I value sharpness of detail more than an excess of contrast, and the shorter time of exposure necessary makes the procedure not only safer, but aids materially in eliminating motion.

As can be seen from the illustrations, the apparatus is very simple in construction and made almost entirely "by hand," so to speak. The supporting members are of galvanized iron pipe fastened to the floor and to the side wall. This part is high enough so that the high tension wires may be brought to the tube and not be near the patient, and far enough away from the wall so that one may have easy access to the film holder from the back. It is heavy enough to insure firmness, and, if desired, a transformer may be mounted on a platform supported by the pipe that is fastened to the wall.

The entire mechanism of the apparatus is attached to the upright pipes or supports by means of roller bearings. It can be moved upward or downward almost the length of the pipe so that it will accommodate a small child or a very tall adult in a comfortable sitting position. The mechanism can be held at any position by means of a set screw.

The mechanism consists of a film-holding device, the front of which is of transparent

celluloid through which can be seen the exact position of the part to be roentgenographed with relation to the center of the exposure area, or, in other words, the operator sees exactly the spot at which the central ray will emerge from the part. This is constant, regardless of the angle of exposure. One may use an 8″ × 10″ film with its long axis up and down or horizontally, or a 10″ × 12″ film horizontally. radiation. If desired, metal mats may be placed in front of the film so that only a small area may be exposed; however, this must be the central part of the film. There is a guide block in the bottom of the film holder which serves to keep the center of the film in position to receive the central ray, when an 8″ × 10″ film is used in the horizontal position. This guide block is removed when 10″ × 12″ films are used,

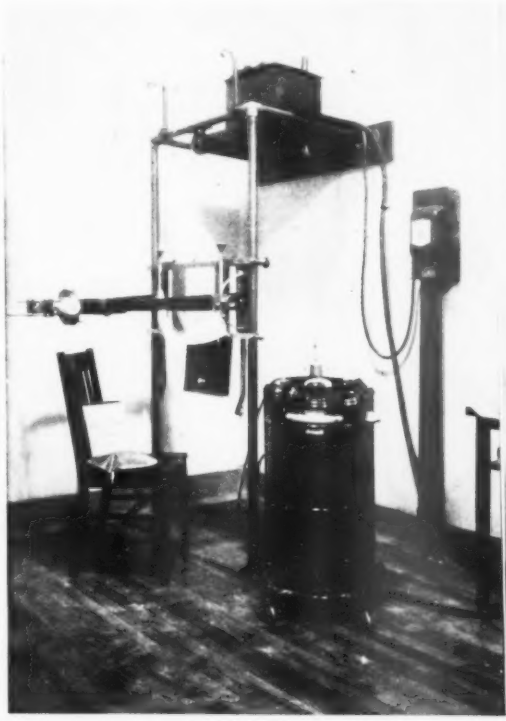

FIG. 1. Apparatus installed as an entirely independent unit. The tube acts as a self-rectifying tube. Tube arms in position so that central ray is at right angles to the face of the film-holder. Note film-holder and compression bag on chair.

FIG. 2. Different view of the same installation. Note pointer projecting from end of cone. This indicates the line of travel of the central ray. This also shows the manner in which the small 10 ma. tube is mounted. The door in back of the film-holder is open and hangs downward.

I do not use metal cassettes but place the double screens and film in the ordinary Eastman film holder. The back of the film-holding device is a door, hinged at the bottom. It hangs downward when open. When the film is placed in position, a soft rubber bag inflated to the right extent is put behind the film so that to close the door it is necessary to compress the rubber bag, and this, in turn, insures firm contact between screens and film. The face of the door is lined with lead to prevent scattered but it is not necessary to remove it to use 8″ × 10″ films in the vertical position.

The tube is the 10 ma. tube made of lead glass except in the exposure area; consequently, an extra protective shield is not required, and the supporting parts need not be heavy for that reason. The tube is supported by means of ordinary tube clamps to a wooden crossbar, fastened at either end to a wooden arm, the other end of which is fastened to the film-holding device by means of bolts. The bolts are on

a level with the center of the film, when it is in place, and they represent the center of circles, the radius of which on either side is the tube-supporting arm. In this way, the tube is always at exactly the same distance from the film and the central ray is always centered on the center of the film.

To the framework supporting the film holder on one side is attached a metal half circle or an arc, the center of which circle is the bolt to which the tube arm is attached, so that this half circle and that described by the tube in its travel have a common center. By means of a clamp the tube arm can be fastened to the metal arc, the surface of which is calibrated in degrees above and below zero, which indicates the horizontal or that the central ray is perpendicular to the center of the surface of the film. There is a small movable metal sleeve over the metallic arc that moves with the tube arm. It has two projecting pins which come in contact with another pin projecting from the tube holder arm. This sleeve-like apparatus can be fastened on the metallic arc at any point by means of a thumb screw and when fastened thus the tube arm can be moved only the distance between the projecting pins on the sleeve-like apparatus, and this distance is just right for stereoscopic exposures. A metal diaphragm and cone-holding mechanism is placed so as to receive the desired part of the rays. The diaphragm may be of any size desired. I have them to expose areas 5, 8 or 10 inches in diameter. A Bowen telescoping indicating tube and rod is attached to the end of the cone, first to center the roentgen-ray tube accurately by seeing the focal point through the tube of the indicating device, and then with the rod inserted, it can be made to touch the head of the patient and indicate exactly the point at which the central ray will enter. This device is removed before making the exposure.

Fig. 3. This shows office installation of apparatus. The door at the back of the apparatus leads into a closet to the high tension transformer. The high tension wires come from overhead leads. Note counterweight at the back and to one side so that it does not interfere with the operator.

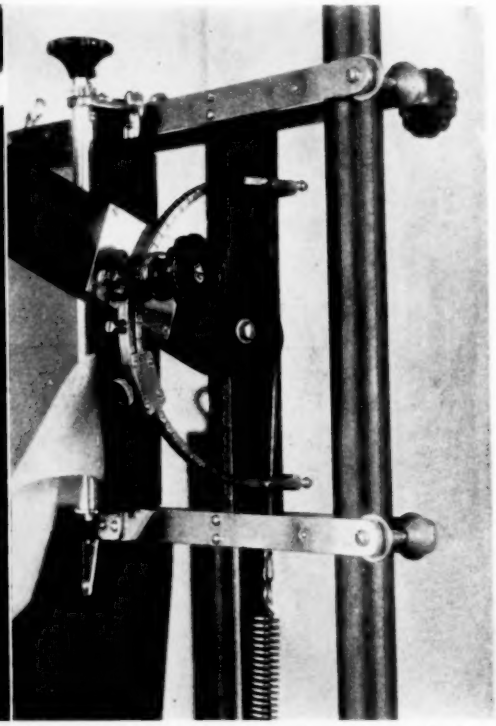

Fig. 4. This shows in detail the arc and clamp; also sliding member on arc which controls the stereoscopic shift. Note also the spring leading to the end of the tube arm, which helps to control the balance of the tube arm. Also note roller bearings on upright and thumb screw for holding mechanism at proper height.

There is a compression band to hold the head in proper position and prevent motion. It is attached on one side but removable on the other side. It operates in the same manner as the compression band supplied with practically all Potter-Bucky diaphragms except that it rolls and is held by rachets on both sides so that the head need not be rotated when the band is tightened.

The entire operating mechanism is moved up and down with ease because of a counterweight. The tube-holding device is counterbalanced to some extent by means of coil springs.*

Briefly, the advantages of this apparatus are as follows:

1. The patient sits in a comfortable position.

2. The procedure is much less terrifying to children than the prone technique.

3. A 10 milliampere tube is used, giving the best possible detail and also rich contrast.

4. The rubber compression bag insures firm contact between screens and film.

5. A large number of exposures may be made, if necessary.

6. The focal point film distance is 28 inches, reducing distortion to a minimum. Both mastoids can be seen in the posteroanterior exposures for the accessory sinuses.

7. Results can be accurately reproduced.

8. If one has an accurate knowledge of cranio-cerebral topography, he can isolate any part, because the point at which the central ray enters and exits is accurately shown or obtained.

9. The posteroanterior exposures of the head are made in from 3 to 5 seconds and the lateral views in from 1 to 3 seconds.

10. The technique is constant. The stereo shift is all in the one direction so that the lateral view of the head is viewed with the patient facing downward or upward. The posteroanterior exposures are viewed in this way whenever sterescopic work is done.

11. The apparatus is useful for all head work and also for the shoulder girdle and cervical regions.

12. It is relatively inexpensive either to buy or build.

* This coil spring counterbalancing device and the small metal sleeve which controls the stereoscopic shift, as well as other details of construction, are to be credited to Mr. Brigham, of the M. H. Bresette X-Ray Company.

ROENTGENOGRAPHIC MEASUREMENT OF OBJECTS BY MEANS OF SPECIALLY CONSTRUCTED STANDARDIZED SCREENS INTERPOSED BETWEEN OBJECT AND FILM

BY GEORGE W. WAGONER, M.D.

HAVERFORD, PENNSYLVANIA

CLINICALLY, roentgenograms are used to delineate the contour, structure, and size of an object. In fulfilling this last function, the measurement of an object, many difficulties have arisen. The methods now in use for measurement are either not accurate or else are so difficult of use as to be of no value as a routine clinical procedure.

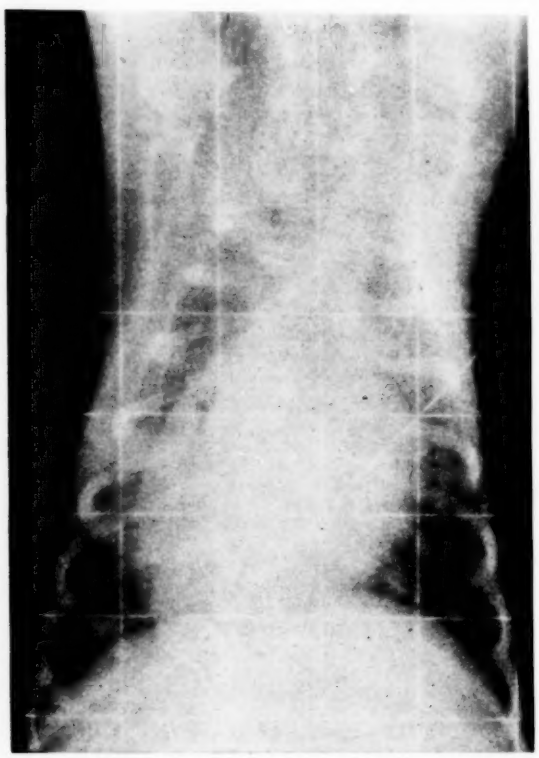

FIG. 1. (Use of wire screen.) Anteroposterior roentgenogram of dog. Note the diagonal wire and the manner in which it could be applied to measurement of the cardiac axis.

This paper presents a method whereby the size of the object roentgenographed is accurately measured. The procedure is simple; the measurements become part of the developed film and hence a permanent record.

Problem. The problem consists in accurately measuring a roentgenographed object by measuring the size of the image obtained. This entails the use of a specially constructed screen.

In roentgenograms the size of the image may or may not be the size of the object. Only when various factors are accurately controlled is it possible to gain an accurate measurement of the object by measuring the image. This is particularly true in roentgenograms of the heart and other deep-seated viscera.

Many attempts at the accurate measurement of objects by the use of the roentgenogram have been made. Such are the various methods for the localization of foreign bodies by the principles of angulation and the diagrammatic or tracing roentgenoscopic method for outlining the cardiac borders. All these methods are open to criticism in that they are not absolutely accurate and are difficult of application.

The relation of the size of the image to the size of the object depends upon certain variable factors. These are (1) the distance of the roentgen-ray tube from the object; (2) the distance of the object from the film, and (3) the angle from which the picture is taken. The first and third factors can be accurately controlled. The second may or may not be subject to control by present methods.

The general practice in controlling the first factor is to place the tube at such a distance that for practical purposes the rays are considered to be coming from infinity and hence traveling in parallel lines. This distance of the tube from the film is usually one or two meters. The second factor, the distance between the object and the film, may be controlled by placing the film in contact with the object. In medical work it is not always possible to place the film in contact with the object,

since the object to be studied is frequently deep seated and the bulk of the intervening tissue irremediably separates the object from the film. The third factor is made constant by keeping the tube at right angles to the film.

Since the distance between film and object is not constant it becomes necessary to develop a method whereby the correct dimensions of the object can be obtained from those of the image regardless of the distance separating the two.

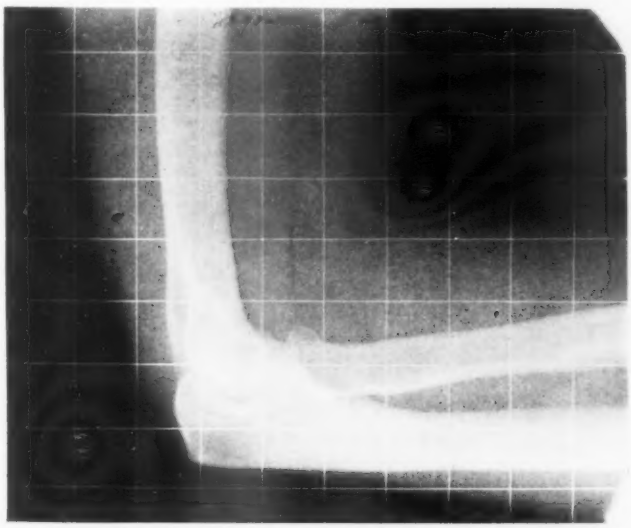

Fig. 2. (Use of wire screen.) Lateral roentgenogram of normal elbow. The screen rulings become a part of the permanent record.

Method and Theory. The proposed method is that of interposing between the object to be roentgenographed and the film a screen or grille whose rulings are opaque to the roentgen ray but whose spaces or interstices are transparent. Thus on the developed film will appear two superimposed images, that of the object and that of the screen.

If the object and the screen be in contact the images of both will be subject to the same degree of distortion; and the image of the screen, the dimensions of which are known, can be used to measure accurately the size of the image of the object and hence of the object itself. In the above case it is immaterial at what distance the tube or film may be from the object and screen. As it is no more possible in medical work to approximate the screen to the object than it is to approximate the film to the object, there enters another factor, the distance between object and screen. When this factor is involved, the image of the screen cannot be used to measure the size of the object unless the different degrees of angulation and distortion to which the screen and object are subjected are taken into consideration.

In order to simplify, the distance between the tube and film is made constant by placing the tube always at a given distance from the film; e.g., 1 or 2 meters. The distance from the tube to the object is disregarded. The distance from the object to the film and the distance from the object to the screen are made one by placing the screen upon and in contact with the film. The tube is kept at right angles to the screen-film. The distance between the object and the screen-film is variable. This variant is due to the thickness of the tissues intervening between the object to be studied and the nearest surface against which the screen-film can be placed. The thickness of the intervening tissues can be measured, in the majority of cases, by the use of calipers and a rule. In other cases this distance can be estimated with relative and sufficient accuracy.

Placing the roentgen-ray tube at 1 or 2

meters distance from the screen-film does not actually render all the rays leaving the target parallel. Therefore, the size of any image thrown upon the film will vary according to the distance of the object from the screen-film.

For the screen used when the object, screen and film are in contact, the unit of ruling was made 2 cm. With the tube at 2 meters there will be no distortion of the image of the object and screen. Now if the object is distant from the screen-film 5 cm., the image of the screen can be made to measure the image of the object by making the actual size of the unit of ruling of the screen 2.048 cm. and retaining the relative value of the ruling, as seen on the developed film, as 2 cm. Should the object be distant from the screen-film 20 cm. then the actual size of the unit of ruling would be increased 2.222 cm., but the relative value of the ruling would remain 2 cm. Reference to Tables I and II will show the

Table I

Object Size, Cm.	Tube Dist., Cm.	Object Dist., Cm.	Image Size Cm.	Image Increase Cm.	Per centage Increase
10	100	3	10.30	0.30	3.0
10	100	5	10.52	0.52	5.2
10	100	7	10.75	0.75	7.5
10	100	10	11.11	1.11	11.1
10	100	15	11.76	1.76	17.6
10	100	20	12.50	2.50	25.0
10	100	25	13.33	3.33	33.3

Table II

10	200	3	10.15	0.15	1.5
10	200	5	10.24	0.24	2.4
10	200	7	10.36	0.36	3.6
10	200	10	10.62	0.62	6.2
10	200	15	10.81	0.81	8.1
10	200	20	11.11	1.11	11.1
10	200	25	11.44	1.44	14.4

Tables I and II express the actual and percentage increase of the size of the image over the size of the object when the distance from the object to the screen-film is varied from 0 to 25 cm.

Table I is based on variations in the object distance when the roentgen-ray target is 1 meter from the screen-film. In Table II the same variations in the object distance are made with the target 2 meters from the screen-film.

percentage increase of the size of the image over the size of the object under variations in object and tube distances. Hence, it is my purpose to prepare a series of screens the rulings of which would be constructed for use in roentgenographing objects at various distances from the screen-film. This would seem to entail a burdensome array of screens. Actually, however, the object would seldom, if ever, be distant more than 15 cm. from the screen-film. Therefore, if a roentgenologist had screens for use at object distances of 0, 5, 10 and 15 cm. he would be equipped for all practical work.

Screens. I. *Rulings.* The general type of rulings used is subject to great variety of detail. In those which I have constructed I have used a series of equal squares, 2 cm. on the side. One or two diagonals are incorporated so that some of the squares are bisected at an angle of 45 degrees.

It is wise to have several squares subdivided so as to give smaller units of ruling. It is only necessary to examine a few of the many rulings used for the counting of blood corpuscles to see the variety of ruling designs that may be employed.

Screens. II. *Construction.*

Two types of screen construction were found to be most satisfactory.

1. Fine metal wires embedded in celluloid gave excellent images but were subject to distortion through expansion and contraction of the metal together with warping of the celluloid sheet.

2. By stretching fine metal wires on a suitable frame and taking a roentgenogram of the same a negative film of the screen was obtained. From the negative a photographic celluloid positive was made. This positive was used as a screen; the fixed silver salts forming the lines proved to be of sufficient concentration to absorb the roentgen rays and cast a faint shadow.

By using photographic films having a higher metal content, screens could be made by photographic process which would cast shadows of a density equal to those cast by wire screens. The manufacture of screens by photography would be simple, cheap and accurate. Screens with different unit rulings can be made by photographic enlargement.

CONCLUSIONS

A simple and accurate method for obtaining a permanent measurement of the size of an object roentgenographed is here presented.

This method is capable of wide application in clinical roentgenography.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

X-Rays and Radium in the Treatment of Diseases of the Skin. By George M. MacKee, M.D., Professor of and Director of the Department of Dermatology and Syphilology, New York Post-Graduate Medical School and Hospital. Second edition, thoroughly revised. Cloth. Price, $10.00. Pp. 788, with 354 illustrations and 31 charts. Philadelphia: Lea & Febiger, 1927.

The first edition of MacKee's book fully merited the wide popularity which it attained. The second edition, reflecting as it does the maturer judgment and ripened experience of the author, is even more worthy of commendation. The following extract from the preface but modestly reflects the thoroughness with which he has done his job: . . . "The book has been thoroughly revised and modernized. Every chapter and paragraph dealing with modern technic and apparatus has been rewritten. New chapters on spectroscopy, ionization methods of measurement, and long-wave-length roentgentherapy have been added. The chapters that have not been rewritten have been revised and the literature has been brought up to date. The revision includes 174 additional pages, 104 illustrations, 9 charts, a number of tables, a dozen diseases and over 300 literary references."

MacKee's work deserves a high place in the archives of roentgen literature, and as a book for both study and reference it is commended to all who are either directly or remotely interested in roentgen or radium therapy.

T. A. Groover.

San Francisco Cancer Survey. Fourth Preliminary Report. By Frederick L. Hoffman, LL.D., Consulting Statistician, Prudential Insurance Company of America, Newark, N. J. Paper. Pp. 228. Prudential Press.

This report deals with statistics regarding the physical facts, habits of living, known impairments, treatment, remedial diagnosis, and family history of living cancer patients in various parts of this country. The information was gathered by means of questionnaires sent out to the local doctors and also by individuals devoting their entire time to this study. It represents a tremendous amount of work and is undoubtedly a step in the right direction.

Only a few localities in this country have been covered so far but the work is to be extended over all parts of the United States and also into foreign countries. The author's intention is to collect such data yearly from each locality since very valuable information should be forthcoming from such a comparison.

His statistics show that cancer is unquestionably on the increase in proportion to the population, but varies widely in its local incidence, according to the organs and parts affected. The parasitical theory of cancer is disproven by the detailed analysis of cancer deaths by streets and houses in the different cities and also in that there is no seasonal prevalence such as would be the case if the disease were of parasitic origin. Additional evidence is also found in that there is no knowledge that cancer has ever completely died out in any one section previously affected.

Other valuable and interesting information is found in the fact that cancer is apparently not related to either tuberculosis or venereal infections and that their occurrence together is purely a coincidence. Heredity does not seem to play quite the rôle that was once thought, but chronic irritation was found to be a very important and constant factor.

The cancer problem is of such vital importance that too thorough an investigation into its various phases is impossible. The author's endeavors should, therefore, receive unlimited encouragement and there seems to be no doubt that very valuable information will be derived from such an investigation.

Edgar M. McPeak.

BOOKS RECEIVED

X-Rays and Radium in the Treatment of Diseases of the Skin. By George M. MacKee, M.D., Professor of and Director of the Department of Dermatology and Syphilology, New York Post-Graduate Medical School and Hospital. Second edition, thoroughly revised. Cloth. Price, $10.00. Pp. 788, with 354 illustrations and 31 charts. Phila. Lea & Febiger, 1927.

Radium in Gynecology. By John G. Clark, M.D., Former Professor of Gynecology, University of Pennsylvania, Gynecologist in Chief to the University Hospital, and Charles C. Norris, M.D., Professor of Obstetrics and Gynecology, University of Pennsylvania, Gynecologist to the Radiologic Staff of the Philadelphia General Hospital; with a chapter on Physics by Gioacchino Failla, E.E., M.A., D.Sc., Physicist, Memorial Hospital, New York. Cloth. Pp. 315, with 49 illustrations. Philadelphia and London: J. B. Lippincott Co., 1927.

DISEASES OF THE MOUTH. By Sterling V. Mead, D.D.S., Professor of Oral Surgery and Diseases of the Mouth, Georgetown Dental School, Washington, D. C. Cloth. Price, $10.00. Pp. 578, with 274 illustrations in the text, and 29 full page color plates. St. Louis: C. V. Mosby Co., 1927.

CANCER CONTROL. Report of an International Symposium Held under the Auspices of the American Society for the Control of Cancer. Lake Mohonk, New York, Sept. 20–24, 1926. Cloth. Pp. 336. Chicago: The Surgical Publishing Co., 1927.

SIR WILLIAM OSLER MEMORIAL VOLUME: Appreciations and Reminiscences with Bibliographies. (Bulletin No. IX of the International Association of Medical Museums and Journal of Technical Methods.) Second impression, edited by Maude E. Abbott, M.D. Cloth. Subscription price, $10.00 Pp. 634. Privately issued at 836 University St., Montreal, Canada, 1927.

MAX VON PETTENKOFER: His Theory of the Etiology of Cholera, Typhoid Fever, and Other Intestinal Diseases; a review of his arguments and evidence. By Edgar Erskine Hume, M.D., DR.P.H., LL.D., Major, Medical Corps, U. S. Army. Cloth. Price, $1.50. Pp. 142, with 8 full-page plates. New York: Paul B. Hoeber, Inc.,1927.

SAN FRANCISCO CANCER SURVEY; FOURTH PRELIMINARY REPORT (SEVENTH AND EIGHTH QUARTERLY REPORTS). By Frederick L. Hoffman, LL.D., Consulting Statistician, Prudential Insurance Company of America, Newark, N. J., Paper. Pp. 228. Prudential Press.

ANNUAL REPORT OF THE SURGEON GENERAL OF THE PUBLIC HEALTH SERVICE OF THE UNITED STATES FOR THE FISCAL YEAR 1927. Cloth. Pp. 355. Washington: U. S. Government Printing Office, 1927.

THE CURRENT SIGNIFICANCE OF THE WORD ALUM. By William D. Richardson, Former Editor, Industrial and Engineering Chemistry. Cloth. Pp. 93. Chicago: The Commonwealth Press, 1927.

POTASSIUM AND TARTRATES: A REVIEW OF THE LITERATURE ON THEIR PHYSIOLOGICAL EFFECTS. By Ralph W. Webster, PH.D., M.D., Professor of Medical Jurisprudence in University of Chicago (Rush Medical College), Chicago, Illinois. With a digest and bibliography of the literature, by W. A. Brennan, A.B., Cloth. Pp. 168. Chicago: The Commonwealth Press, 1927.

ABRIDGED SCIENTIFIC PUBLICATIONS FROM THE KODAK RESEARCH LABORATORIES. Volume X, 1926. Paper. Pp. 247, with illustrations. Rochester: Eastman Kodak Co., 1926.

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HISTOLOGIE UND CHEMIE DER LIPOIDE DER WEISSEN BLUTZELLEN UND IHRE BEZIEHUNG ZUR OXYDASEREAKTION, SOWIE ÜBER DEN STAND DER MODERNEN HISTOLOGIE DER ZELLIPOIDE. Von Dr. Ernst Sehrt, Freiburg i. Br. Paper. Price, 6 Marks. Pp. 53, with 9 tables. Leipzig: Georg Thieme, 1927.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

ALBERTI, OLINDO. Some complications secondary to perforation of gastroduodenal ulcers. *Radiol. med.*, Sept., 1927, xiv, 729–767.

The author describes 4 cases of different abdominal complications resulting from gastroduodenal ulcers: two of subphrenic abscess on the right side, one of hepatic abscess and one of spontaneous ambulant pneumoperitoneum. There was one very unusual finding in the roentgen pictures unknown in the literature; there was a long and tortuous fistulous tract injected with barium in two of the cases connecting the duodenal perforation with a subphrenic abscess in one of the cases and with the intrahepatic bile ducts in the other. The author thinks perforation of a gastroduodenal ulcer is much more frequent than has generally been believed because it can be shown in many cases by roentgen examination when there are no clinical symptoms or only ones that are misleading. He says that many of the classical symptoms described in the textbooks, such as serious general condition, violent abdominal pain, fever, leucocytosis, radiation of pain to the shoulder, hiccup, vomiting, edema of the walls of the abdomen, etc., are often lacking. He then gives differential diagnostic signs from other conditions, especially thoracic ones, with which such perforations may be confused and also from intrahepatic abscess. He discusses different technical devices used to demonstrate perforations. Roentgen examination is also valuable in treatment for it may enable a diagnosis to be made early enough so that the operation can be performed in time to save the patient.

ARMANI, LODOVICO. Roentgen findings in scleroderma. *Arch. di radiol.*, May-June, 1927, iii, 576–590.

Six cases of scleroderma are described with roentgenograms. There are two kinds of roentgen symptoms in this disease, direct and indirect. The direct signs are destructive changes in the bones of the extremities, but these may be confused with the signs of Raynaud's disease. The indirect signs which consist of changes in the lungs and malformations of the sella turcica and the lumbar spinal column are more useful in making the diagnosis. These findings should be verified by a study of a larger number of cases.

ASTI, L. M. The roentgen picture of detachments of the epiphysis at the elbow. *Radiol. med.*, Aug., 1927, xiv, 625–643.

The author first describes the order in which the centers of ossification of the ends of the bones which form the elbow appear and then emphasizes the care in technique necessary in taking pictures of this region to avoid getting deformed pictures. But from experiments he has made he does not believe these deformities are of such a nature as to cause a diagnosis of detachment when it does not exist. He discusses and gives roentgenograms of detachment of the condylo-trochlear block as a whole, detachment of the external condyle, of the epicondyle, the epitrochlea and the head of the radius. He does not give pictures of detachment of the trochlea and the head of the ulna because in more than 800 cases of traumatism of the elbow he has never seen any. He emphasizes the difficulty in interpreting some of the roentgenograms and the rarity of cases of true detachment of the centers—particularly of the external condyle.

BARBACCI, G. Roentgen diagnosis of lesions of the spinal cord with lipiodol. *Radiol. med.*, Aug., 1927, xiv, 663–674.

A description is given of the results obtained by the use of lipiodol in 4 cases, one of epidural tumor, one of Pott's spondylitis, one of fracture of a vertebra and one of gumma of the cauda equina. In all of the cases the method was successful; the opaque column stopped at the point where the canal was occluded by the lesion and the form of the opaque mass gave some indications as to the nature of the lesion. The author advises injecting 1–2 c.c. of lipiodol and then putting the patient in the Trendelenburg position. The method is valuable in spite of its defects. It should not be used until clinical and roentgenological examinations have been made but should then be used to supplement them before any operation on the spinal column. Injection should not be made in active lesions of the cord unless operation is to be performed soon. Sometimes the iodized oil passes along the nerve sheaths of the cauda to a great distance. It is preferable to make the injection in the lumbar region. It should not be made high up unless operation is to be performed soon so that the lipiodol will be removed.

BERTOLOTTI, M. Pathology of the optic nerve canal. *Radiol. med.*, Oct., 1927, xiv, 918–926.

The author finds that stereoroentgen examination of the optic nerve canal is of great value in the diagnosis of diseases of the canal. Contrary to what might be supposed, pathological bony stricture of the canal is extremely rare. In the cases in which it does occur concentric compression of the part of the nerve which runs through the canal causes changes which lead to concentric limitation of the visual field without central or paracentral scotoma. There were only two cases of this kind in the material studied by the author. Rhinogenous optic neuritis in the great majority of cases differs hardly at all from the other forms of retrobulbar neuritis of toxi-infectious origin and the mechanism of its pathogenesis is the same.

BIANCHI, G. Roentgen picture of bile sand. *Radiol. med.*, Nov., 1927, xiv, 949–976.

The author is convinced that the direct roentgen demonstration of gallstones is much more important than the indirect cholecystographic signs. Not only stones but bile sand can be demonstrated, as he shows by the clinical description and roentgenograms of a number of cases. The roentgen picture of bile sand is not very well known, although the author thinks it is quite characteristic and by no means infrequent when the picture is known and a careful search made for it. The chemical composition of bile sand is characteristic and can often be differentiated from that of ordinary hepatic calculi. This sand is often visible because there is a large amount of it and because it has a considerable calcium content. It always contains quite large amounts of calcium, which is the most opaque constituent of gallstones, while cholesterin, which is one of the constituents most transparent to roentgen rays, is generally contained in it only in very small quantities, if at all. In several of the author's cases the diagnosis was confirmed by operation; it may also be confirmed by the presence of bile sand in the stools.

The author describes the picture of bile sand in detail; it consists essentially of more or less dense partial or total visibility of the shadow of the gall-bladder, the sand acting as a contrast medium contained in the gall-bladder, provided it is there in large enough quantity and has a sufficient calcium content. The smaller the amount, the larger the calcium content must be to make it visible. The roentgen visibility of the gall-bladder, the value of which in the diagnosis of cholecystitis has given rise to much discussion, may be due in some cases, and the author thinks in a considerable number, to the presence of sand in the gall-bladder. But this roentgen sign must be looked for carefully and repeatedly, as the picture given by the sand varies greatly in intensity at different times and this may cause mistakes in interpretation. The author thinks it important to make a roentgen differentiation between bile sand and gallstones, particularly as it is hard to make such a differentiation clinically and sand requires a different treatment from the majority of calculi, and its pathogenesis is also probably different.

BIGNAMI, GIUSEPPE. Calcifications of the liver shown by roentgen examination. *Radiol. med.*, Oct. 1927, xiv, 851–859.

A case is described in a woman aged fifty-seven; there was no family or personal history of any importance and she did not have syphilis. She began to lose weight rapidly and at the end of a year was in a condition of profound marasmus. She had no fever, her liver was large and rather hard with several little nodules on its surface with one large one in the epigastrium. The feces contained fat; she did not have icterus. Roentgen examination showed a dozen almost round opaque shadows of different sizes in the liver; they were homogeneous and some of them had indistinct and some jagged edges. Intrahepatic calcifications are rare and the author reviews the different diseases in which they may be found. He thinks that in this case they were probably calcifications of neoplastic nodules because the roentgen picture seemed to be that of calcified tumor and the clinical course also indicated tumor of the liver.

BLOODGOOD, JOSEPH COLT. What every radiologist should know about bone tumors. *Radiology*, March, 1927, viii, 195–203.

The author has divided his discussion of bone tumor under several headings. He first discusses irradiation versus curetting or resection in the benign giant-cell tumor and states that up to 1923 it was shown that curetting would accomplish cures just as well as amputation. Thorough irradiation of giant-cell tumors is better than amputation. Patients so treated regain the use of their limbs, with varying degrees of ossification of the diseased parts. In some cases, however, pre-operative roentgen-ray treatment is often a waste of time, but no harm is done directly. Based on 250 observations, the author is inclined to believe that the ultimate treatment of benign giant-cell tumors will be curettement with chemical and thermal cauterization. When the bone shell is intact, irradiation should not be performed, since the

intact bone shell is ideal for curettement. If the bone shell is partially destroyed, irradiation may be used to advantage, but curettement is the quickest and safest procedure.

In the roentgen-ray diagnosis of central lesions, it is difficult to distinguish the different pathological processes in the bone marrow. The earlier the lesions and the more intact the bone shell, the harder it is to make differentiation. However, in the majority of surgical clinics the diagnosis of bone lesions by means of roentgenograms is more advanced than diagnosis by biopsy. In cases of myeloma and metastatic carcinoma and curable forms of multiple central lesions, positive roentgen-ray differentiation is impossible and biopsy is justifiable.

There is further discussion of the use of the roentgenogram and biopsy in the diagnosis of such tumors. Comparative studies of roentgen-ray findings are of paramount importance and case reports should be published in detail. Pathologists should make special studies of this type of tumor so that malignancy can be more promptly reported. In case of doubt as to the diagnosis from the roentgenogram and the microscopic study, it is safer to treat the condition as benign. Before resection or amputation is resorted to, the diagnosis of malignancy must be as positive as is possible.

Bordoni, Luigi. Double phalanx of the right thumb in a patient with acromegaly. *Radiol. med.*, Sept., 1927, xiv, 775–781.

A man of sixty-two presented a case of non-hereditary but congenital double accessory phalanx and double nail of the right thumb. One of the phalanges which was normal in size and form articulated with the inner half of the distal surface of the first phalanx, while the other was inserted into the external half of the same phalanx from which it diverged. Both were covered with a bridge of soft tissue, giving the thumb a triangular form with its base outward. The patient also had signs of acromegaly.

The author reviews the different kinds of congenital malformations of the fingers, particularly polydactylia and polyphalangia and emphasizes the importance of making a distinction between polyphalangia with the phalanges arranged in a row and the divergent form seen in this case which is extremely rare. He thinks the malformation in this case was probably of hypophyseal origin.

Borelli, F. Clinical and roentgen study of cysts of the pancreas. *Radiol. med.*, Sept., 1927, xiv, 810–820.

Three cases of cyst of the pancreas are described which were verified by autopsy; the roentgen pictures showed compressions and displacements of the stomach and intestine by the cyst, which made roentgen diagnosis possible. The roentgen picture depends on whether the cyst extends above the stomach, between the stomach and transverse colon, above the transverse colon or between the folds of the transverse mesocolon.

Brams, Julius. Injection of pilonidal cyst with lipiodol. *Radiology*, March, 1927, viii, 248–249.

This is a report of the use of lipiodol for demonstrating the position and extent of a pilonidal cyst. The sinus was injected with lipiodol and the patient tilted with head down and roentgenogram made. Very satisfactory roentgenograms were obtained.

Brunetti, L. A case of racemose osteoplastic pneumopathy. *Radiol. med.*, Nov., 1927, xiv, 981–984.

Fourteen cases of this disease have been described in the literature but they have all been autopsy findings; this is the only case diagnosed during life. This is natural as it causes no symptoms and this one was found only by chance in the course of a roentgen examination made for sclerosis of the aorta. In addition to moderate sclerosis of the aorta the picture showed branching bone structures in the left lower lobe. They were of various shapes, long, curved, angular, cylindrical or club-shaped, and are compared to the forms assumed by melted lead when it is dropped into water. The histological picture of these structures is that of typical bone with a marrow cavity and compact peripheral bone. They are scattered irregularly in normal lung tissue and their arrangement has no relation to the structure of the lobes. There are no signs of inflammation around them. There is probably a congenital predisposition to the disease and it comes on in late life following diffuse catarrhal conditions. This patient was a man of forty-six who had had recurrent attacks of bronchitis since the age of eighteen.

Cignolini, P. Saline concretions in the pineal gland. *Radiol. med.*, Nov., 1927, xiv, 1000–1005.

Saline granules can be found in the pineal gland similar to those seen in the dura mater or choroid plexus. They are probably precipitations of phosphate or carbonate of calcium or magnesium due to disturbance of a saline secretion of the gland. The author thinks they are not normal and insignificant but that there

is a relation between these saline concretions of the pineal gland and hypogenitalism. In an occipitofrontal projection these concretions appear as small dark spots a few millimeters in diameter situated in the median sagittal plane at a greater or less distance above the ethmoid plane. The most of them are generally at the occipital end of the gland. They are of various sizes, some of them up to 4–5 mm. in diameter, or they may be so small as to be barely visible. The author saw one case of almost total calculosis with a large central cyst.

CRESPELLANI, CARLO. A case of inflammatory diverticulum of the appendix. *Radiol. med.*, Oct., 1927, xiv, 848–851.

A brief description is given of the roentgen picture in a case of inflammatory diverticulitis of the appendix. There was an ovoid shadow situated to the median side of the cecum and beneath its fundus. It showed only after a meal of barium sulphate and not after an opaque enema. The ovoid structure emptied partially on manual expression as was shown by a change in its form. Operation confirmed the roentgen diagnosis.

D'AMATO, G. The diagnostic importance of negative findings in cholecystography. *Radiol. med.*, Nov., 1927, xiv, 993–999.

On the basis of 300 cholecystographies by the intravenous method D'Amato shows the great diagnostic value of a negative result in which the shadow of the gall-bladder cannot be seen. Such a negative finding might be due to insufficiency of the liver or to impermeability of the bile tract, but insufficiency of the liver would generally be shown by marked clinical symptoms so in the great majority of cases it is due to impermeability of the cystic duct or the gall-bladder itself. This impermeability may be caused by catarrhal icterus, inflammation of the wall of the cystic duct or gall-bladder with cicatricial contraction of the lumen, compression of the duct or gall-bladder by tumors of the surrounding organs, carcinoma of the bladder or duct or the presence of calculi. Cholecystography is negative in about 20 per cent of the cases of gallstones. Stones may cause impermeability by becoming impacted in the duct, or the gall-bladder itself may contract around concrements so that bile cannot enter it. A negative result may furnish one of the clearest indications for operation.

EDLING, LARS. Roentgenology of pulmonary anthracosis. *Acta radiol.*, 1926, vi, 369–390.

An examination was made of 46 coal miners from southern Sweden, the examinations being made without any knowledge of the clinical facts, which were later compared with the roentgen findings. The subjects were generally in good health, some of them suffering only from a chronic bronchitis and emphysema.

According to the roentgen findings, these cases may be divided into three groups: (1) Cases without characteristic signs of anthracosis. Most of these showed intensified and enlarged hilum changes and a lung structure resembling that of chronic bronchitis; a few showed slight traces of a mottled appearance of the lungs. (2) Cases with roentgenologically fully developed anthracosis, characterized by a well-defined mottled structure throughout both lung fields, as a rule symmetrically distributed on both sides. The detailed appearance of this mottling varied somewhat according to the technique employed. In good pictures the individual spots were mostly not bigger than a pinhead, commonly arranged in reticular figures or striated rows along the lung branches. Roentgen pictures from such lungs inflated after death, displayed a sponge-like or reticular structure with innumerable small nodules. The mottled structure in anthracosis does not, as in miliary tuberculosis, occupy the apices of the lung; and with the latter the shadows are more even and more diffusely spread than with pneumoconiosis. Moreover, within this group there were generally found the same lung changes as described in the first, and frequently also emphysema and bronchiectasis.

(3) Fully developed anthracosis with large solid densities of the lung tissue. In this group there were observed very marked enlargement and density of the hilum shadows, bronchiectasis and advanced emphysema, and also compact, mostly well-defined and very often symmetrically localized shadows of varying form and size situated sometimes in the hilum regions, sometimes at the apices or in the subapical parts of the lungs.

Coexistent chronic tuberculosis was diagnosed in only one case and suspected in 2 or 3 others. Histologically the coal dust occurs in these lungs as very small round black grains without admixture with any foreign particles of other kinds and lying free in alveoli, in phagocytes or along lymph channels of the lung tissue. The macroscopically indurated parts which correspond to the solid shadows were microscopically characterized by atelectasis, hyperemia, stasis and edema only and showed no fibrous induration of any kind. There was no sign of tuberculosis anywhere, only a pronounced bronchiectasis in the larger air passages.

The relation between gravity of the lung

condition and duration of work in the mines is shown by the following: In Group I the mean age was thirty-nine years and the average duration of work in the mines fifteen years; in Group II the mean age was fifty-one years and work in the mines thirty years; in Group III the mean age was sixty-four years and work in the mines averaged forty-one years. It appears therefore that the lung changes found in Group I develop within the first ten to twenty years of work, the fully developed anthracosis does not appear until after work in the mines for at least twenty to thirty years and the changes characterizing the last group are due to very prolonged exposure of at least forty years.

FECI, RENZO. Chronic osteomyelitis or tumor metastasis. *Radiol. med.*, Sept., 1927, xiv, 768–774.

A man aged fifty-seven had been operated upon for a tumor of the kidney pelvis which was benign clinically and on histological examination. Some time later he began to have signs of chronic osteomyelitis of the left tibia. Roentgen examination showed the picture of tumor of the head of the tibia rather than that of osteomyelitis but at first the clinician refused to accept this diagnosis because of its lack of harmony with the clinical findings. But finally the patient's condition became so bad that operation was decided upon and roentgen examination of the thorax at this time showed many metastatic foci in the lungs which had not caused any clinical symptoms up to that time. This indicated that the bone lesion too was a metastasis from the original kidney tumor. This case shows the importance of roentgen examination in the differential diagnosis of chronic bone lesions. It may also show, as it did in this case, that a tumor, apparently benign clinically and histologically, may be really malignant.

GARVEY, JOHN L., and GLASS, ROBERT L. Tabetic spinal osteo-arthropathy. *Radiology*, Feb., 1927, viii, 133–139.

Four cases are reported of undoubted tabes dorsalis associated with spinal osteo-arthropathy. Each case gave a definite history of primary luetic infection and presented the cardinal signs and symptoms of tabes dorsalis. Examination of the spine in each case disclosed the following signs considered characteristic of tabetic spinal osteo-arthropathy: a deformity of the lumbar spine (the site of predilection of the condition), painlessness, increased mobility, absence of tenderness and lack of muscle spasm. The roentgenographic findings were in all cases conclusive, showing destruction of bone and joint spaces occurring with bony proliferation.

Tabetic spinal osteo-arthropathy can be detected on physical examination but not from the patient's subjective complaints. It occurs independently of trauma to the spine and in spite of antisyphilitic treatment. The spinal lesion in each case followed late upon the original syphilitic infection. The condition may be associated with arthropathy elsewhere.

GRASHEY, R. Calcified mesenteric vessels. *Acta radiol.*, 1926, vi, 466–468.

A report is given of a case in a woman aged seventy-nine. Roentgen examination of the stomach showed, in addition to hyperperistalsis, a hitherto unobserved picture. To the left of the distinctly malacic and scoliotic lumbar spine, there was present a shadow presenting all the characteristics of a blood vessel calcified, partly longitudinally and partly transversely. Another roentgenogram with the tube placed more caudally showed the same shadow shifted cranially, a proof that the structure lay anterior to the spinal column. Some shadows lying a little higher had the appearance suggesting calcified glands. Further examination disclosed marked calcification in the femoral artery and its branches.

It was concluded that the structures seen below the margin of the second lumbar vertebra were the roots of the mesenteric artery. The patient died but autopsy was refused. However, roentgen pictures of the post mortem preparation of another case showed the calcified splenic and renal arteries to produce such deep shadows that they would surely have been roentgenographically detectable during life.

GROEDEL, FRANZ M. The anatomical diagnosis from the roentgenogram of the degree of pulmonary tuberculosis. *Acta radiol.*, 1926, vi, 469–472.

Further report is made of the advantages of a method of teleroentgenography in which the tube focus is 2 meters from the chest wall, as usual, but with the roentgen plate placed 20 cm. back of the chest wall and not directly upon it. This method was employed in a study of 2 cases of pulmonary tuberculosis, which are briefly described. These illustrative cases show that the new method gives a sharper definition to the image of the shadow than does the ordinary teleroentgenographic procedure. In addition, more of the shadow image is made visible. As a result, the image appears more distinct in size, shape, limits and density.

The new procedure therefore accomplishes a

considerable advance in the diagnosis of the extent of tuberculous lung processes and also of the qualitative anatomical characters of the disease. Of special importance from the standpoint of prognosis is the better representation of those cavities which cannot be discovered clinically.

HAENISCH, F. Roentgen findings in fistula formation between portions of the intestinal tract (colon-duodenum-stomach, stomach-jejunum-colon, duodenum-gallbladder) of varying etiology (tumor, ulcer, cholecystitis). *Acta radiol.*, 1926, vi, 485–501.

Three cases are reported describing the roentgen findings in fistula formations between parts of the intestinal tract. In the first case, the left flexure had broken through into the stomach and the duodenum. In the second case, one of gastric ulcer after gastroenterostomy, a fistula developed into the colon. In the third case, cholecystitis had caused the development of fistula between the gall-bladder and the duodenum.

For diagnostic purposes irrigoscopy is very much to be recommended, in addition to the usual contrast meal examination, in cases of fistula of the stomach and colon. In studying the contrast meal, the retrograde filling of the stomach from the large intestine is also instructive. Successive roentgenograms are desirable when taken in conjunction with roentgenoscopy. It is possible to detect a filling of the large intestine very soon after the ingestion of food. The filling of the distal portion of the large intestine before passage through the ileocecal valve is also of diagnostic importance if the ascending colon is empty. In irrigoscopy the diagnosis is confirmed when barium masses become demonstrable in the upper coils of the small intestine or in the stomach. Under certain circumstances, filling of the large intestine with air is also a promising procedure, through the evidence of the entrance of air into the stomach.

HAUDEK, MARTIN. Results of continued roentgen observation in pulmonary tuberculosis. *Acta radiol.*, 1926, vi, 502–530.

Conclusions drawn as to the anatomical character of tuberculous changes in the lung from a single examination are unreliable. A series of observations obtained after two or several roentgenoscopies and photographic records after short intervals provide much more valuable diagnostic and prognostic information. Serial examinations should not be neglected in those cases in which the first examination has disclosed confluent or flaky opacities with indefinite outlines. These opacities being of a more labile character have a tendency to undergo rapid changes, in contrast to the sharply defined nodular and streaky shadows which have their fixed anatomical bases. These formations presenting the appearance of exudative focal inflammations are frequently congestive pneumonias capable of regressions and ultimate recovery after a few months or even a few weeks, and they are not pneumonias with unfavorable prognosis tending to caseation and necrosis. These formations are termed by the author signs of transient pneumonia. The residues of the latter, namely, thickened pleura, dense streaks and scattered foci resemble in every respect those of productive inflammations.

The spontaneous healing tendency of tuberculosis is particularly demonstrated in those cases periodically examined in whom large cavities have disappeared after several months of hospital treatment without surgical interference. The indefinite dim outlines are demonstrable not only in lobar and lobular pneumonic opacities (mostly of bronchogenous origin) but were also in those spread by the hematogenous route. The latter, however, last only for a very short time, often only for a few days. They are due to perifocal inflammation (collateral edema) which surrounds the newly developed focus and soon becomes absorbed. The dim outline thus indicates a continued activity of the focal process.

HELLMER, HANS. The roentgen diagnosis of strictures of the small intestine. *Acta radiol.*, 1926, vi, 534–544.

An account is given of the roentgenological symptoms of cases of stricture of the small intestine with particular reference to the part played by the folds of the mucous membrane in the production of the roentgen picture of the prestenotic portion of the intestine. Five illustrative cases are cited representing different localizations and degrees of the stricture-producing process.

If the process lies in close proximity to the pylorus or the ileocecal valve, the conditions for precise roentgen diagnosis are very favorable. To this group belong strictures in the duodenum, in the duodeno-jejunal flexure, in coils of gastroenteroanastomoses and in the distal portion of the ileum, in all of which a definite local diagnosis can be made and the nature of the alteration identified. If the stricture is located in any other portion of the small intestine it is generally not possible to form a conclusion as to the nature of the process from the roentgen finding alone. However the clinical diagnosis permits a somewhat

better differentiation. Oftentimes, however the clinical picture is unable to yield a definite interpretation.

The symptoms of stricture of the small intestine are partly direct and partly indirect. The latter are sometimes of stenosis. The direct symptoms consist of local changes in the diameter of the small intestine and in the mucosal relief. Unfortunately, the direct symptoms in the major portion of the small intestine do not occur early, but are registered sometime after the indirect symptoms have made themselves evident.

The symptoms of stenosis are: (1) delayed emptying of the channel with accumulation of fluid and gaseous contents above the obstruction; (2) as a result of stagnation the lumen of the intestine increases in width and length, sometimes enormously; (3) "stenosis peristalsis" may occur and be quite marked; (4) the "wreath shaped" arrangement of the stenosed coils, appearing most characteristically in the jejunum; (5) so-called ribbing of the shadow of the small intestine.

Holmes, George W. Benign giant-cell bone tumors. *Acta radiol.*, 1926, vi, 597–606.

In this study, roentgenograms of 79 benign giant cell tumors have been reviewed and compared with a large number of other forms of benign and malignant tumors of bone, and the following conclusions have been drawn: (1) The roentgenographic appearance of benign giant cell tumors is fairly characteristic and constant; (2) these tumors may occur at any age, but are rare in the long bones before the epiphyses have united; (4) they are trabeculated; (5) they cause bulging and thinning of the cortex, but do not break through or invade the soft tissues, except when the bone is fractured; (6) they frequently extend into the condyle and tuberosity, and may cross from one bone to another along the ligamentous attachments; (7) a good roentgenogram may be of greater diagnostic value than a single pathological specimen.

Imboden, H. M. A very unusual case of spondylolisthesis. *Acta radiol.*, 1926, vi, 615.

The woman, aged thirty-six, presented herself for examination of the lower spine, the complaint being constant pain referred to the lumbosacral region. Exaggerated lumbar lordosis was present, and the fourth and fifth lumbar and the sacral spinous processes were prominent. No tenderness was elicited on deep palpation and on forced movement. The lateral view revealed the fifth lumbar displaced forward so that the body was not in contact with that of the sacrum. A shelf of bone seemed to lie immediately beneath the body of the fifth lumbar and was probably an attempt made by the sacrum to provide an auxiliary support.

Operation revealed the fifth lumbar spinous process and the entire neural arch as very small and displaced forward on the sacrum for a distance of an inch or more. It was loose on the sacrum, but not as loose as might be expected from its position. There was no sign of fracture. The fourth was well developed and seemed more freely movable on the fifth than is found normally. The tip of the spinous process of the fifth was jammed tightly against the base of the sacrum. A small bursal surface was formed between the sacrum and the fifth, while the normal bursae were observed between the spinous processes of the rest of the vertebrae.

Jacobaeus, H. C. On bronchography in cases of purulent lung-affections. *Acta radiol.*, 1926, vi, 616–630.

Six cases of purulent lung affection are described, most of them cases of bronchiectasis, in which bronchography with lipiodol was performed for diagnostic and also for therapeutic purposes. To throw light on the value of the method, the roentgen examinations with and without lipiodol were compared with one another. In the first case, the lipiodol method was the only roentgenological means of obtaining a clear idea of the real position and appearance of the bronchiectasis. In the second case, the lipiodol method yielded only little of diagnostic value. Therapeutically the repeated lipiodol injections brought with them a certain improvement of the symptoms. In the third case, very important diagnostic information was obtained; therapeutically there was a slight but evident change for the better. In the fourth case, the limitation of the method was demonstrated. A formation of mucus probably obstructed the lumen of the bronchus leading to an abscess (in this case a chronic one) and thus prevented the lipiodol from entering and filling the cavity. The fifth case gave a striking illustration of the utility of the lipiodol for diagnostic processes in the presence of bronchiectasis; therapeutically the lipiodol had no effect, nor the treatment by pneumothorax, which remained incomplete on account of adhesions. In the sixth case, information of diagnostic value was obtained by the lipiodol injection.

Kinney, Lyell C., and Elliott, A. E. Explosive fractures of the upper end of the humerus. *Radiology*, March, 1927, viii, 245–247.

Attention is directed to the necessity for careful examination of roentgenograms of injuries to the head of the humerus in order that the more or less faint indications of explosive fractures may be noted. Comminution of the head of the humerus is more frequent than is usually recognized, but detailed observations of roentgenograms give a means of more accurate diagnosis of the extent of the injury. This is possible by a study of the cancellous architecture, which is usually difficult because the discontinuity is not easily discernible. There is little displacement of fragments and little irregularity of outline. For this reason it is necessary that the roentgenograms show in sharp detail the architecture in the cancellous network. This detail must be as good as that required in dental films and the roentgenograms of the mastoid. Films made in perpendicular planes, in both internal and external rotation, will uncover more fracture lines than the one stereoscopic pair. By means of this accurate information the proper procedures can be determined and much injury avoided. For this purpose it will be necessary to describe the entire injury and not the major fracture alone. Since explosive fragmentation of the head frequently accompanies injuries to this region, the author emphasizes the importance of this additional care in the making and examination of roentgenograms.

LASCHI, G. Roentgen pictures in lobar pneumonia simulating tuberculosis. *Radiol. med.*, Nov., 1927, xiv, 1005–1011.

It is a well-known fact that an ordinary bronchopneumonia may give a roentgen picture very much like that of certain forms of tuberculosis. The roentgen picture of lobar pneumonia undergoing resolution may also show pictures the differential diagnosis of which is very difficult. Generally it requires observation of the clinical course to show the nature of the disease in these cases. When the roentgenologist is called in to give a diagnosis, just because the clinical picture is atypical, the ordinary experience acquired in observation of tuberculous cases is not always sufficient to enable him to make a definite diagnosis.

Two cases are described in which the roentgen pictures were very strongly suggestive of tuberculous cavities. In one of these patients in whom the pneumonia had begun with a violent hemoptysis, the picture had returned to normal again in four days. The second case was one in which resolution of a pneumonia had been followed for some time by slight fever and râles. The roentgen picture in this case too indicated that the pneumonia had occurred in a tuberculous lung, but in another picture taken a month later the pathological signs had disappeared entirely. The author discusses the difficulty in differential diagnosis and emphasizes the need for caution in interpreting such pictures and the necessity of repeating the examination at intervals.

MEDA, GIULIO. Fibrous and deforming osteopathy with special reference to Paget's disease. *Radiol. med.*, Oct., 1927, xiv, 885–917.

The author describes 4 cases of Paget's bone disease which he followed up for a long time with repeated examinations, and analyzes the roentgen pictures of all the bones involved, particularly the tibia, skull, pelvis and spinal column which are the favorite sites of the disease. From the roentgen point of view the characteristic features of this bone disease, which tends to systematic diffusion, are deformity, increase in size and change in structure of the bones, in which there is a combination of osteoporosis and hyperostosis. When the lesions are well developed they often give a characteristic spongy appearance but this is not always true. In the beginning of the disease and in the less typical cases or when the lesions are exclusively of the sclerotic or rarefying type differential diagnosis may be very difficult, particularly from Recklinghausen's fibrous ostitis. A good many authors think that Paget's disease and Recklinghausen's disease are slightly different manifestations of the same affection, a fibrous ostitis or ostosis; Paget's or Recklinghausen's disease or the transition forms may develop according to the age and reactive capacity of the subject. The author does not believe this theory which is based on the similarity of the histological picture. The substitution of fibrous connective tissue for bone marrow is only an ordinary form of cirrhosis, which is not at all specific but occurs in various diseases, and it is not enough to show the identity of Paget's and Recklinghausen's diseases, which are quite different clinically and roentgenologically. The author then discusses the differential diagnosis between Paget's disease and several inflammatory, neoplastic and dystrophic diseases of bone, with more detail for syphilis, leontiasis ossea and eburneous osteosis, of which he reports cases.

MEZZARI, ANTONIO. Presacral bilateral gluteal communicating abscess of vertebral origin. *Radiol. med.*, Nov., 1927, xiv, 876–981.

The author presents photographs and roentgenograms of a case of Pott's abscess which

had originated in the bodies of the last lumbar vertebrae and after having hollowed out a large cavity in front of the sacrum had flowed into both the gluteal regions, forming two symmetrical collections which communicated with each other through the large presacral sac. He thinks in this case the abscess did not follow the nerve tracts as it did in the lumbosacral abscess of Löffler which extended from the lumbar plexus to the sacral and continued to the thigh along the extrapelvic course of the sciatic. A little of the intrapelvic part of it lay beneath the iliac fascia, while the greater part was subserous and retroperitoneal. The extrapelvic part of it probably extended down between the deep and middle folds of the gluteal fascia.

Möller, P. Flemming. The redundant colon. *Acta radiol.*, 1926, vi, 432–457.

Reports are given of 18 cases of undoubted redundant colon, in all of which enormous redundancy of the large intestine was present. In 14 of the cases the large kinked flexures had given rise to more or less distinct symptoms of obstruction, rather grave in character in some instances. Only 2 of the cases were accidental clinical findings.

The author is of the opinion that the redundant colon is more frequent than is generally assumed and that the condition very often leads to serious clinical disturbances. The possibility of redundant colon should always be kept in mind and a roentgen examination should never be neglected in those cases showing symptoms referable to torsion phenomena and having obscure pains in the abdomen of colic-like character, and other intestinal disturbances.

In 15 of the present series of cases the redundancy was found in the sigmoid flexure. In one case the redundancy was in the descending colon; and 2 other cases showed redundancy in both the ascending and transverse colon.

Morse, Russell W., and Cole, Lewis Gregory. The anatomy of the normal small intestine as observed roentgenographically. *Radiology*, Feb., 1927, viii, 149–153.

To secure roentgenographic visualization of the small intestine the following conditions must be fulfilled: (1) an opaque medium must be used of such composition and consistency that it will pass out of the stomach at a fairly rapid and uniform rate of speed; (2) the medium must be of sufficient consistency to pass evenly and preferably fairly slowly through the intestine; (3) roentgenographic examinations must be made at intervals which will show the various parts of the small intestine when they are best filled. A moderately thick paste of barium sulphate and water has proven the most successful opaque medium.

The serial roentgenographic examination of the stomach is made immediately after ingestion of the meal. Comparative roentgenograms made in both the prone and erect positions showed that the position of the small intestine varies but little in the two postures; that the loops of the small intestine are more discrete in the prone position; that there is no appreciable distortion of the small intestine in the prone position.

The inner surface of the mucosa, however, is modified in character by the changes in the muscular wall of the intestine and also by pressure on the intestine from without. The roentgenographic outline of the inner wall of the intestine is therefore an expression not only of the surface of the mucosa but also of the muscular coats of the intestine and of certain conditions existing outside of the intestine itself.

The anatomical study showed the duodenum to be relatively fixed in position in the form of a loop, the opening of the loop facing to the left and superiorly. Depending upon the relative position and angulation of the superior, descending and inferior parts the duodenum may be shaped like the capital letters C, V and U, or may be almost rectangular in shape. The first part of the duodenum is best visualized in the prone oblique position. The folds of the mucosa are usually low in height and few in number. The duodenojejunal flexure is usually the highest fixed point of the small intestine. From the duodenojejunal flexure the intestine passes forward and usually inferiorly toward either the right or left side.

The second group of coils which forms the first part of the mesenteric small intestine is usually located in the left hypochondrium and the loops may descend above the level of the duodenojejunal flexure. The third group of coils is usually located in the left lumbar region and the loops may descend below the plane through the superior iliac spines. Almost uniformly both of these groups extend slightly beyond the right side of the spine. The fourth group of coils is usually found in the umbilical and upper hypogastric regions. The fifth group is usually observed in the right lumbar region and the sixth group is usually located in the right iliac fossa and the false pelvis or lower hypogastric region. Distinct visualization of the separate loops of the fourth, fifth and sixth groups depends largely upon their positions in the abdomen.

The surface of the mucosa of the small intestine is characterized by the presence of numerous circular, spiral and crescentic folds. They are most numerous and of greater height in the duodenum and the first loops of the mesenteric small intestine. They diminish somewhat in height and number through the fourth and fifth groups of coils. In the sixth group they are short and less numerous and may be absent in the terminal part.

Rapid uniform emptying of the stomach will give a large caliber to the intestine throughout the entire length in which the meal is present. If the stomach empties itself intermittently the distribution of the meal and the caliber of the small intestine will be irregular.

The most apt description of the roentgenographic appearance of the ileocecal valve is that made by Cole a long time ago: "The small intestine protrudes into the cecum at the ileocecal valve like the head of a cobra that is standing on its tail."

PANSINI, GIROLAMO. Method of intratracheal injection by intubation. *Arch. di radiol.*, May-June, 1927, iii, 561–575.

This method is proposed for the laryngotracheal injection of iodized oil into the bronchi for roentgen examination. The syringe and straight and curved cannulas used are illustrated. Under local cocain anesthesia the cannula is introduced through the glottis and the oil injected. The patient opens his mouth wide and extends his tongue. The operator introduces the index finger of his left hand and finds and fixes the epiglottis, at the same time pressing the tongue as far down as possible. The patient is then told to swallow and the movement raises the larynx so that the finger that holds the epiglottis comes into contact with the arytenoids and localizes them. When the swallowing movement is completed the larynx descends to its original position. The patient is then told to breathe deeply and the cannula is introduced along the index finger and passed through the glottis.

The method is really simple, although it requires some practice to do it well and quickly. It has the advantage that the roentgenologist can do it himself and does not require the aid of a specialist when he wants to make such an examination. It is much easier than an intubation in stenosis of the larynx because the tissues are not swollen, the child is not suffering and the anesthesia makes the manipulation easy. It can be used for patients of any age.

PASSI, ERMANNO. Roentgen demonstration of fragments of glass. *Arch. di radiol.*, May-June, 1927, iii, 525–547.

Experiments are described in which the author made a study of the opacity of different kinds of glass and different sized fragments. He finds that the opacity of glass to roentgen rays depends on its thickness and on the percentage of heavy metal, especially lead, in its composition. A thick piece of glass containing a high percentage of lead is absolutely opaque. If a definite history is not available it may be difficult to differentiate in the human body between a bit of glass with a high percentage of lead in its composition and bits of metal. In such cases if there is not even a slight trace of transparency a good point in differential diagnosis is the regular triangular or rectangular form of the fragments and the clearness of their outlines, which are characteristics of glass fragments as distinguished from metal ones. Even if the history is not exact it is not hard to recognize bits of glass in the limbs if they are not less than a tenth of a millimeter in thickness. But even with a history it is hard to demonstrate thin bits of glass that are not very opaque in the skull, thorax or abdomen, particularly if they are deep and near to bones, because the difference in the coefficient of the glass and that of the viscera or bone may be slight. In looking for bits of glass assumed to be in the human body, particularly if they are not very opaque, it is best to use soft rays.

PESCATORI, G. Roentgen study of ulcer of the posterior wall of the stomach. *Radiol. med.*, Aug., 1927, xiv, 655–662.

The ulcers of the stomach that are hardest to diagnose are those of the posterior wall and the author shows the importance in the diagnosis of these ulcers of examining the inner wall of the stomach. He describes a case of ulcer of the posterior wall of the body of the stomach, verified by surgical operation, in which the direct roentgen sign of ulcer was an opaque ring, caused in all probability by the deposition of opaque medium around the elevated edges of the ulcer.

PICCININO, GUIDO. Incidents in the injection of lipiodol. *Arch. di radiol.*, May-June, 1927, iii, 591–593.

The first case was in a man of forty in whom a diagnosis of abscess of the lower lobe of the right lung had been made and an injection of lipiodol into the bronchial tree was decided upon. The injection was made into the intercrico-thyroid space with a curved needle. Within a few minutes after the injection was begun the patient showed intense dyspnea and in a little while subcutaneous emphysema of the neck developed. His condition improved

gradually without treatment but at the end of three days there was still some emphysema of the neck. The air must have passed through the puncture opening, either because of defective elasticity of the intercricothyroid membrane or because the injection was made a little too low in cartilage.

The second case was one of intraspinal injection in a man of thirty. Following a fall on the back he had spastic paraplegia with disturbances of sensation and incontinence of the sphincters. Roentgen examination showed flattening of the 12th dorsal vertebra, probably due to fracture, but this did not explain all the symptoms so a suboccipital puncture was made and 1 c.c. lipiodol injected. It immediately came back through the needle and immediately afterward the patient had vomiting, headache and disturbances of deglutition and small rapid pulse. In 3–4 days he had pneumonia of both bases followed by gangrene and death. Autopsy was refused. It might be argued that death was due to pneumonia and not to the puncture but experiments on animals have shown that on puncture of the medulla injuring the restiform body the animals do not die at once but in a few days have pneumonia, which is a deglutition pneumonia. This shows that to produce a vagus pneumonia it is not necessary to cut that nerve, but it is sufficient to injure the pneumogastric fibers in the restiform body. The author thinks the death in his case was due to injury of the restiform body. It is the fourth case in the literature of death from suboccipital puncture.

Piccinino, Guido. Advantages and defects of cholecystography. *Radiol. med.*, Sept., 1927, xiv, 788–794.

The author has used the method of Graham and Cole in about 70 patients. He describes the technique and compares the oral and intravenous methods of administration, which he finds absolutely without danger. He says there are very few cases in which morphological changes are found in the gall-bladder; in most cases judgment has to be based on functional signs. But these symptoms do not make an anatomical diagnosis possible, for different diseases, even ones that do not involve the gall-bladder at all, may cause the same kind of functional symptoms. He then reviews in detail the results of examinations made in cases of sub-hepatic tumor, hepatic calculi and calcifications in the right upper quadrant of the abdomen, and shows that very often cholecystography does not settle the doubts which remain after clinical and ordinary roentgen examination. He finds that its chief value lies in finding what organ is the site of the disease and then the findings must be completed by the usual clinical and roentgen examinations.

Picot, M. Study of spondylolisthesis. *J. de radiol. et d'électrol.*, Aug., 1927, xi, 419–423.

A case is described in a soldier, aged thirty-nine, admitted to the hospital with a diagnosis of left sciatica. He had been perfectly well until he was kicked by a horse. After a rest of two months he took up his work again but eight years later suddenly had pain in his legs, particularly in the left one, for which he was sent to the hospital. The roentgen picture showed a forward displacement of the 5th lumbar vertebra on the sacrum. Without this roentgen picture the diagnosis could not have been made in this case which was clinically one of ordinary radiculitis. Apparently the kick had fractured the neural arch, which had consolidated with elongation of the arch and enlargement and deformity of the vertebral foramen; the weight of the body had then caused the vertebra to glide forward.

Podesta, Vittorio. Variations in the roentgen findings in gastric neurosis. *Arch. di radiol.*, May-June, 1927, iii, 548–560.

The patient, a man of fifty, was very neurasthenic. His stomach symptoms had been attributed by different physicians to neurasthenia. He had poor appetite, vomiting and abdominal pain with stubborn constipation. His color was cachectic and he had tremor of the muscles of the upper limbs and of the face. Roentgen examination with ordinary barium paste showed the picture of hour-glass stomach; the pylorus was displaced to the right and the stomach appeared to be displaced upward. There was a moderate degree of distention of the colon. The same picture was found on three examinations at intervals of three days. There was no gastric peristalsis; the emptying time of the stomach was normal. The most probable diagnosis seemed to be adhesive perigastritis. An examination was then made by the combined method of barium paste and insufflation. The stomach was found dilated but with no hour-glass constriction and its outlines apparently normal. The patient was sent back to his physician for two weeks on a diet before making a final decision. He improved greatly during this time and at the end of it said he had no stomach symptoms. Examination with Rieder's paste showed the stomach dilated, ptotic and a little atonic but with no sign of organic lesion. The roentgen findings were those of gastric tetany with the exception that the colon did not show the extreme dilatation usually found in

that disease. In view of this fact and the association with tetany of certain muscle groups, particularly the masseters, the author thinks this was a case of primary gastric tetany.

PORRO, NICOLO. The roentgen picture of polycystic kidney. *Radiol. med.*, Aug., 1927, xiv, 674–683.

A case of polycystic kidney in a man, aged forty-seven, is described and illustrated with pyelograms. The lesion was bilateral and the diagnosis was verified clinically and by anatomicopathological examination. The pyelograms were of the type found by other authors in the few cases of this disease that have been examined in this way. There was enormous elongation and dilatation of the calyces, the upper and lower calyces being widely separated. The author emphasizes the importance of pyelographic examination because of the difficulty or even the impossibility of diagnosing polycystic kidney clinically when the enlargement of the kidney is unilateral or when, as sometimes happens, it is lacking entirely. Differential diagnosis from tumor of the kidney is based not only on the characteristic type of the pyelogram but also on the fact that bilateral tumor of the kidney is rare while unilateral polycystic kidney is unusual. In case of palpable unilateral tumor, generally on the right, roentgenoscopy may show that the left kidney, the one that most easily escapes clinical detection, has developed upward, while the right one has extended into the iliac fossa, pushed downward by the liver. In this case roentgenoscopy may show that the diaphragm is pushed upward abnormally and so assist in making a diagnosis of polycystic kidney instead of tumor.

RATTI, A. Stenosis of the small intestine from tuberculoma. *Radiol. med.*, Nov., 1927, xiv, 985–993.

The patient was a woman of thirty-seven who in childhood had had frequent and prolonged attacks of bronchitis and bronchopneumonia. Two children died in infancy, one of bronchopneumonia and the other of meningitis. For about six months she had had a subjective feeling of contraction of the intestine with pain and borborygmus; she felt as if a wave of contraction starting from the left lower quadrant passed toward the suprapubic region and then rose again into the right lower quadrant. This came on a half hour to three hours after meals and was sometimes accompanied by vomiting. Objective examination of the thorax showed signs of sclerosis of the right apex and roentgen examination showed adhesions of the base of the right lung to the diaphragm from pleurisy. Roentgen examination of the abdomen showed a single obstruction in one of the lowest loops of the small intestine. An opaque enema passed through the large intestine and cecum to the ileocecal valve without any obstruction. Operation and histological examination showed that the obstruction was caused by a hyperplastic tuberculoma.

REVIGLIO, G. M. Roentgen picture of lesions of the long bones in nursing infants caused by congenital syphilis. *Radiol. med.*, Oct., 1927, xiv, 869–884.

The author has made a study of the lesions caused in the long bones of infants by congenital syphilis and finds that each of the different diseases has a characteristic roentgen picture. Two varieties of bone lesion, osteochondritis and generalized ossifying periostitis, are pathognomonic of congenital syphilis in very young infants; they are not seen in congenital syphilis in later childhood nor in acquired syphilis in infancy. But the other varieties, rarefying osteomyelitis, gummatous osteoperiostitis and localized gummatous osteomyelitis, are not so characteristic, for they are seen also in acquired syphilis and late congenital syphilis. Rarefying osteomyelitis it seems is seen quite frequently in the first few months of life while gummatous osteoperiostitis and localized gummatous osteomyelitis are rather rare in very early infancy. These bone diseases from congenital syphilis sometimes do not attract the attention of the clinician. Roentgen examination is a valuable means of diagnosing them and of showing the form, location and extent of a syphilitic bone disease, so a systematic roentgen examination should be made of any infant in whom congenital syphilis is suspected.

SALOTTI, A. Change of position of the stomach and large intestine in the two fundamental positions of roentgen examination. *Radiol. med.*, Aug., 1927, xiv, 643–655.

The author has made a study of the extent to which the normal stomach and large intestine can be moved in the two fundamental roentgen positions—the horizontal and vertical—and reports the results which he has obtained by orthodiagraphy. He gives the skin projections and the average measurements of the distances between the principal points of the stomach, that is, the cardia, pylorus and lower border of the greater curvature, and of the colon, that is the cecum and the splenic and hepatic flexures, and constructs two triangles, a gastric and a colonic one, to serve as outlines

for the three morphological types of De Giovanni. In these types the displacements of the chief points with relation to the fixed points of the skeleton are maximum in the longilinear-asthenic type and have a tendency to be lateral; they are moderate in the plethoric-adipose type and generally longitudinal and least in the harmonic-hyperesthenic type and generally median. In order to show in a rapid and accurate way to what point any organ moves, the author makes two roentgenograms on the same plate in the two positions and illustrates the results in certain normal and pathological cases; these can always be transferred to the diagrammatic triangles which he constructs by orthodiagraphy.

He is convinced that his method will prove useful in showing the exact degree of mobility of an organ, dependent on its tonus, its ligaments and the influence of neighboring organs, and give signs valuable in the diagnosis of lesions inside or outside the viscera.

Sheldon, Francis B. The importance of teeth in routine gastro-intestinal examinations. *Radiology*, March, 1927, viii, 241–244.

In a large series of patients suffering from gastrointestinal disturbances the author has found that 85 per cent of those who submitted to thorough dental examination, including roentgenograms of their teeth, showed definite evidences of alveolar infections. That such infections are contributing factors to abdominal diseases which are indeed secondary infections seems to be proven in these cases, since marked recovery followed in many cases in which the offending teeth were removed. A perfunctory examination of the outside of the teeth by the dentist is not enough, for in a number of instances such inspection has shown the teeth to be in apparently normal condition, whereas roentgenograms showed serious alveolar infections. Although these conditions may exist for long periods of time without apparent injury to the gastrointestinal tract, secondary infection may at any time result from general lowered resistance or infection may be transmitted from the apical abscesses through the blood stream to the intestinal tract. In either case removal of the diseased teeth either prevents such conditions from developing or, removing the source of infection, the gastrointestinal condition will be alleviated. Patients suffering from pyorrhea will, when masticating their food, swallow some of the exuding pus and may directly infect the walls of the abdomen and intestines.

In many cases in which gastrointestinal symptoms are presented, there is no evidence of pathological lesions, and yet roentgenologic examination of the teeth reveals pus pockets, pyorrhea and apical abscesses. After these conditions are corrected, either by removal of the teeth or instrumentation, the abdominal pains and the attending symptoms cease. Three typical cases are reported briefly. The author is convinced that roentgenologic examination of the alveolar processes must be included in the routine gastrointestinal examination.

Trostler, I. S. Parotid fistula: case history. *Radiology*, March, 1927, viii, 248

A rather remarkable case is reported in which use is made of the roentgen ray in closing a parotid fistula. The patient, a girl, aged eight, two and a half years previously had had a radical mastoid operation which was followed within the next four months by two mastoid operations on the same side. During the time intervening from the last operation until the patient was brought to the attention of the author, there was a clear discharge from an opening just posterior to the tragus. This clear liquid proved to be saliva. After various methods to induce healing has failed, including radium treatment, the following administration of roentgen rays was employed: 60 ma. for 10 minutes, at 70 kv. peak, 12 inches anode skin distance, filtered through 5 mm. sole leather and 3 mm. aluminum. This treatment was given at 2:30 P.M. The following day the discharge had stopped and the area was dry from 7 A.M. The area became moist again ten days following the treatment, but another administration of roentgen rays as before caused the discharge to stop completely, and the sinus healed. No further evidence of discharge had occurred to date.

Vajano, D. A case of essential stenotic periduodenitis of the duodenojejunal angle verified by operation. *Radiol. med.*, Sept., 1927, xiv, 795–809.

A woman of thirty-five presented a case of stenotic periduodenitis of the duodenojejunal angle which was diagnosed by roentgen examination and verified by operation. Roentgen examination showed total atonic dilatation of the duodenum with prolonged stagnation of the barium, particularly at the lower genu, and active peristalsis. The fourth portion of the duodenum was completely above the lesser curvature of the stomach to the duodenojejunal angle and could be felt on palpation as a hard, stretched cord. The stomach appeared to be considerably displaced to the left as a result of the dilatation of the duodenum. The

bulb was dilated but its outline was entirely regular, as shown by many serial roentgen examinations.

Surgical operation showed a little flat scar from an ulcer on the anteroposterior surface of the bulb, very thick adhesions of all the mesocolic part of the duodenum and particularly at the duodenojejunal angle, and a very pronounced deviation of the first loop of the jejunum; the latter pulled backward and toward the midline by adhesions had closed the angle. The gall-bladder was normal and did not show any calculi.

The author discusses the question of whether it is possible to have ulcer of the bulb without causing any deformity that can be seen on roentgen examination and he agrees with Akerlund that only penetrating ulcer of the duodenum always causes deformity, but that superficial, non-penetrating ulcers of the duodenum may form without causing any irregularity of the outline of the bulb, which is probably what occurred in the above case. The adhesions in this case were probably due to syphilis; the Wassermann reaction was positive.

ZORZI, PIETRO. Study of gastric secretion with opaque pastes. *Radiol. med.*, Aug., 1927, xiv, 683–713.

The author discusses the results of his study of human gastric secretion with opaque meals. He used different types of opaque meal: (1) Simple opaque meal; simple suspension of barium sulphate in water (200 gm. gelobarine and water up to 400 c.c.); (2) excito-secretory meal; 100 gm. barium sulphate in aqueous suspension with cacao and vanillin; volume 400 c.c.; (3) opaque meal of semolina gruel; same volume as the others; (4) milk opaque meal; suspension of 200 gm. barium sulphate in milk; same volume as the above.

With these four types of opaque meal he found the same number of types of gastric chemism. With meal 1 total acidity low, free hydrochloric acid moderate; with meal 2 total acidity moderate, free hydrochloric acid high; with meal 3 total acidity and free hydrochloric acid minimal.

In a general way, it may be said that the secretory type of the stomach remains the same with the opaque meals and the Ewald meal, but that with the former there is almost never hyperchlorhydria in the usual sense of the word except with meal 2. From about 70 cases which the author observed it appears that the opaque meals have a certain tendency to give less stomach residue (quantity of stomach contents forty-five minutes after taking the meal). A study of the secretion curve by fractional removal of the contents shows that gastric secretion with an opaque meal without food is brought about particularly by the action of the autonomous innervation of the stomach.

As to the possibility of producing an opaque meal which would have the same effect as a Ewald breakfast, the author thinks it would be possible to produce a meal that would have the same effect as the clinical meal so far as secretion is concerned, but that it would not have any advantage from the point of view of motility and that it would not overcome the difference that sometimes exists between the evacuation time of two meals by the same stomach, as these differences are due in all probability to different physical properties of the two meals which act in different ways on the function of the pylorus.

ROENTGEN AND RADIUM THERAPY

CAMPLANI, MARIO. A case of sarcoma in a scar resulting from radiodermatitis? *Radiol. med.*, Oct., 1927, xiv, 841–848.

The author describes a case of sarcoma with fusiform cells that developed in a scar on the face resulting from treatment ten or twelve years ago of a tuberculous lupus in a woman who is now forty-two years of age. Roentgen rays constituted a part of the treatment and the author thinks that the irradiation may have helped to cause the tumor.

DOUB, H. P., BOLLIGER, A., and HARTMAN, F. W. The relative sensitivity of the kidney to irradiation. *Radiology*, Feb., 1927, viii, 142–148.

The kidney is the most susceptible organ so far as anatomical changes and loss of function are concerned. The susceptibility of other organs to *chronic* changes as a result of roentgen irradiation is in the following order: intestine, stomach, pancreas, ovary, spleen, lung, adrenal, liver. The susceptibility of the organs to *acute* changes after irradiation were in the order of severity as follows: intestine, adrenal, kidney, spleen, liver, ovary and pancreas. Direct irradiation of the kidney is shown to produce nephritis with hypertension in clinical cases as well as in experimental animals and it follows, therefore, that direct irradiation should be avoided clinically, especially in the young individual.

Two cases of kidney injury as a result of deep roentgen irradiation are described. In addition, the authors report having received information regarding 16 cases of nephritis developing or

becoming clinically recognizable during or after a course of deep therapy.

EIKEN, TH. Roentgen treatment of actinomycosis. *Acta radiol.*, 1926, vi, 391–398.

Four cases are described in which roentgen treatment gave excellent results; similar results were also obtained in 3 other cases. In most of these cases the disease is described from the clinical findings as a cervico-facial actinomycosis. In 2 of the cases the roentgen treatment resulted in a cure since the patients have remained free of recurrence for one and a half years and two and a half years respectively. In the third case only a small residual focus of infection remains after the treatment. One of the cases was a typical actinomycotic appendicitis in which the gram-positive mycelia were definitely detected. The wound refused to heal satisfactorily until roentgen treatment was begun. Recovery resulted in one and a half months, and the patient has remained cured for two and a half years.

The roentgen treatment of actinomycosis demands as strong a dose as the skin can tolerate safely. The author employs two-thirds of an erythema dose (2 to 3 Sabouraud-Noiré) filtered through 5 mm. Al, administered three times with intervening pauses of a month each, then after an interval of three months, a new series of three treatments is given if required, or to make certain of the result. If still another treatment is contemplated one should wait at least another six months. In the case of deep processes distant irradiation in moderate doses is to be employed. It is emphasized that other effective remedies are to be combined with the roentgen treatment in order to secure the most satisfactory results.

ERSKINE, ARTHUR W. X-ray therapy in functional thyroid disease. *Radiology*, Feb., 1927, viii, 140–141.

For patients with mild symptoms, who are under control and wish to avoid an operation with its attendant danger, loss of time and expense, roentgen treatment is the method of choice. This treatment is contraindicated when the disease is progressing so rapidly that it is obvious that permanent damage will be done in two months, and for such cases surgery should be advised. On the other hand, substernal goiter is a positive indication for roentgen treatment. Surgical removal of substernal goiter is a difficult and dangerous operation and is not justified unless roentgen treatment has been ineffective. It is almost impossible to overemphasize the importance of rest and the elimination of focal infection in the management of functional thyroid disease.

The author regards the roentgen treatment as a minor operation and tries to prepare the patient by giving them full doses of iodine for a week before each treatment. Unpleasant reactions seem to be less frequent and less severe as a result. The dose of roentgen rays is about 300 E.S.U. (measured in air) of such a quality that half the radiation is absorbed by 3.25 cm. of water. The physical factors are as follows: 135 kv., 5 ma., 0.25 mm. Cu plus 1 mm. Al, 20 min., 40 cm. skin distance, for the first two treatments and 30 cm. for the later ones. The dose is applied to a single large area which includes the thyroid and thymus. It is repeated ten days or two weeks later, and if it is well borne the dose is increased to 450 units of the same quality which is given every two, three or four weeks, as the needs of the case seem to require.

EWING, JAMES. Radiation osteitis. *Acta radiol.*, 1926, vi, 399–412.

Brief descriptions are given of (1) endothelial myeloma of the tibia; (2) giant cell tumor of the lower end of the femur, and (3) osteogenic sarcoma of the lower end of the femur. A study of these and other cases illustrates the great difficulty of interpreting the significance of the behavior of bones under external irradiation. It is clear that moderate irradiation greatly reduces the vitality and growth capacity of bone cells and the bone forming function; but this effect is slowly recovered from and bones unite after fracture by the formation of an unusually hard callus. After more severe irradiation, such as falls within the upper limits of therapeutic measures now commonly employed, there may be established a progressive, productive osteitis which may cause very marked thickening of the shafts at the expense mostly of marrow cavity, and in the case of cancellous bone may largely replace the fat and cellular marrow by poorly formed and brittle bone or calcified osteoid tissue.

Severe therapeutic irradiation of bone produces a peculiar change in the structure and composition of lamellar bone which shows itself by increased fragility and a marked tendency to spontaneous fracture. Under favorable conditions, however, such fractures may heal slowly. In one case of giant cell tumor receiving 100,000 mc-hr. of radium in packs, a fracture above the tumor area healed after a delay of one year. After such irradiation the bone is nearly devoid of circulation and the periosteal vessels are generally much sclerosed. Complete death of bone of a peculiar type appears to occur in some cases after heavy external irradiation by roentgen rays or radium. The doses required for this effect are above

those which it is desirable to employ for any therapeutic purpose, and reach a limit of eight to ten hours of high voltage roentgen rays and 100,000 mc-hr. of radium in the form of radium packs, 2 mm. brass filtration, 6 cm. skin distance. By properly spacing the exposures over a long period it may be possible to avoid the devitalization of hard bone, but the danger of producing such a result must be considered whenever the higher limits of dosage are employed.

The marked susceptibility of bone is probably due primarily to the action of secondary rays upon the delicate cell processes lying in the canaliculi, and secondarily to physical changes in the composition of the bone lamellae which become very brittle. Radiation necrosis is characterized by the long delay in sequestration and by the resistance of the tissue to solution. Bone devitalized by radiation but escaping infection probably acts as does transplanted bone and is slowly replaced by new bone as the tissues gradually recover from the radiation. Bone devitalized by radiation is extremely susceptible to infection with spreading suppurative periostitis. Such bone cannot be sterilized, and the affection may remain latent giving rise to "flares;" and in it carcinoma grows readily. The probability of causing bone necrosis is generally a distinct contraindication to the use of radiation in the treatment of carcinoma. Unless extreme care is used to sterilize the area and to avoid infection such cases usually succumb to pain, intoxication and exhaustion.

Certain osteogenic sarcomas, especially those forming bone or fibrous tissue, may bed evitalized and have growth arrested by external irradiation. The required dosage for roentgen rays is four to eight hours in divided doses of high voltage, or in more accessible cases low voltage; for radium 40,000 to 100,000 mc-hr. in the form of radium packs, 1 to 2 gm. of emanation, 2 mm. brass filtration, skin distance 6 to 10 in. Outlying portions of tumors are more difficult to control than the central portions when the circulation is unstable. By such treatment the bone shaft is rendered very brittle and prone to spontaneous fracture, the periosteum is injured and its capacity to restore the shaft is impaired and a persistent mass of indolent tissue prevents the restoration of function in the limb. In very vascular tumors there may be rapid progressive aneurysmal dilatation of blood sinuses whose walls are necrotic, so that rapid growth of the tumor is simulated. These results suggest that more reliance should be placed upon the fractional method of smaller doses over a long period aiming merely at growth restraint in the treatment of this group of diseases.

EYMER, HEINRICH. Should cancer of the uterus be operated upon or irradiated? *Strahlentherapie*, 1926, xxiv, 149–152.

The author finds justification for the viewpoint that carcinoma of the neck of the uterus should be treated principally by irradiation, while carcinoma of the body of the uterus should be treated mainly by operation so long as better results cannot be obtained by improved radiation technique.

In carcinoma of the neck of the uterus operability is relatively easy; however, the operation is a big one and hazardous. The primary mortality is very great and the results are poor. The absolute percentage of cures obtained by irradiation are, to say the least, not worse and in the case of operable cases, much better than obtained by surgery. At the same time, the primary danger of the treatment is slight. In addition, emphasis should be placed on the fact that, on the average, 10 per cent of the cases classed as inoperable can be rendered free from carcinoma for at least five years by irradiation. On the other hand, in carcinoma of the body of the uterus, the operative procedure is relatively easy and of little danger. Moreover, operability of this type of cancer is usually good and the operative mortality slight. The results of operation have been fairly good, while the results of radiation therapy are not quite so good.

FRAENKEL, S. R., and NISSNJEWITSCH, L. M. Roentgen treatment of surgical inflammatory processes. *Strahlentherapie*, 1926, xxiv, 73–100.

The effect of small doses of roentgen rays in the treatment of inflammatory processes is most probably of a purely local character, for the bactericidal properties of the blood, contrary to the views of Heidenhain and Fried, are as a rule not increased after irradiation. The roentgen treatment of chronic purulent processes in soft tissues yields satisfactory results in a large majority of cases. Such treatment, however, cannot entirely replace surgical treatment. However, there is no doubt that the roentgen rays constitute a very valuable therapeutic factor which considerably accelerates the recovery process when used in conjunction with surgical treatment.

The indication for roentgen treatment of purulent processes must be decided by the surgeon and roentgenologist jointly, for in every case it is necessary to have an individualized estimate of the disease process. The

roentgen therapy of surgical inflammatory processes is now being subjected to a further exhaustive study, with the aim of establishing precise indications and contraindications for the application of suitable doses of roentgen rays in the numerous conditions to which it is applicable.

FRANKLIN, WALTER SCOTT, and CORDES, FREDERICK C. Radium therapy in some ocular conditions. *Surg., Gynec. & Obst.*, 1927, xliv, 701–702.

Several cases of ocular lesions treated with radium are presented. These cases are more or less isolated ones but the results have been definite enough to warrant the assumption that the effect obtained was due to the therapy applied. Two cases of conjunctivitis had failed to respond to the usual treatment and radium therapy was instituted. Ten mg. radium element in an 0.8 cm. circular plaque screened by 0.5 mm. silver and a piece of rubber dam was applied over the closed lids for one hour at a distance of 1 cm. This was repeated twice a week to each eye for a period of four months in the first case and six months in the second case. At the end of the treatment the condition was markedly improved.

Description is given of a case of vernal conjunctivitis. The treatment was similar to that described above and considerable improvement resulted. The case is not yet cleared up and further radium therapy is contemplated.

A case of recurrent pterygium with hypertrophy was treated with radium, a 53 mc. capillary tube screened only by a strip of adhesive plaster being held directly to the pterygium for four minutes. Two weeks later the patient had a well-defined radium reaction that subsided gradually and coincident with this the granulation tissue disappeared. Only one application was deemed necessary.

A case of corneal malignancy received the following treatment: The eye was cocainized and 143.6 mc. (emanation) in a small capillary tube screened with 0.5 mm. silver and 0.5 mm. aluminum was applied to the cornea over the mass for a period of five minutes. In two weeks the mass seemed a little smaller. After another week 264 mc. were applied for three minutes with the same screening. Three weeks later a 10 mg. plaque, the same as for the first case described above, screened with 0.1 mm. Al and rubber dam was applied for five minutes. This was repeated a month later. The tumor was now half its original size and the blood vessels definitely smaller. The latter dose was repeated two times more with intervening pauses of about three weeks. About a month later, i.e., about five months after the first treatment, 135 mc. screened only by a piece of adhesive was applied directly to the cornea for two minutes. This application was followed by a mild local reaction. The corneal process gradually subsided so that by the eighth month only a flat scar remained in which there were several small areas that gave the appearance of calcification. The blood vessels were now barely visible. Subsequent observation has shown no change in the condition.

GAARENSTROOM, G. F. Is radiation treatment justified in operable cancer of the neck of the uterus? *Acta radiol.*, 1926, vi, 458–465.

The results of radiation treatment of operable cancer of the neck of the uterus, as reported by different authors, show 30 to 50 per cent cures. The author reports 5 cases restored to health for eight, seven, seven, five and four years respectively. Since the results of radiation therapy are already equal to those obtainable by surgery, the author concludes that radiation therapy is advisable for the operable form of uterine cancer. Where operability is doubtful and operation itself dangerous, radiation therapy is the only form applicable.

Difficulties and failures in the past have been due largely to inadequacy of the radiation therapy. It is believed that the best method of treatment consists in a combination of roentgen rays and radium. The employment of external irradiation either with roentgen rays or radium alone may be followed by considerable regression of the tumors but permanent healing is never accomplished.

GOIA, I. A case of excessive bleeding ameliorated by roentgenotherapy. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 555–558.

Excessive bleeding of the gums and nose was treated by the usual methods without effect. No thrombocytes were observed on repeated examinations: there were 3,000,000 erythrocytes and 6,000 leucocytes. Coagulation time was ten minutes. Intravenous injection of sodium citrate, 3 gm. per day, had no effect, and even the addition of calcium chloride caused no noticeable improvement. However, irradiation of the spleen for twenty minutes was effective in stopping the nose-bleeding and the hemorrhages of the gums on the following day. By the fourth day the patient was greatly improved in general condition and there were no new hemorrhages. The coagulation time was reduced to three minutes. After ten days' treatment the patient was discharged

as cured. Irradiation of the spleen did not increase the number of blood platelets, but it is assumed that the improvement was due to the favorable effect of the irradiations on the endothelial cells.

GRAGERT, O. Genital and peritoneal tuberculosis in the female. *Strahlentherapie*, 1926, xxiii, 594–603.

A statistical report is given on 44 cases of genital or peritoneal tuberculosis treated at the Woman's Clinic, Greifswald. Most of the cases occurred in patients under forty years of age. The treatment varied somewhat with the particular characteristics of the case. In the so-called dry form of peritoneal tuberculosis, operative procedure was avoided and roentgen treatment was applied directly. In the exudative type a small incision was made and ascites fluid drained off before roentgen treatment. In all cases, precautions were taken to preserve the function of at least one of the ovaries. Wherever there was definite contraindication to surgical intervention, roentgen treatment was resorted to at once. The present roentgen treatment consists in the administration of the effective depth dose at the diseased area corresponding to 54 per cent, i.e., the "tuberculosis dose" according to Seitz and Wintz. This dose was probably exceeded many times. In the case of tuberculosis of the serosa, an interval of ten to fourteen days was left between the time of the trial laparotomy and the irradiation of the whole abdomen, front and back, with protection of the small pelvis.

It is doubted if mild irradiation of genital tuberculosis is applicable in every case, especially in those cases that cannot be prepared operatively by the removal of the acutely diseased parts. In the author's experience, mild doses upon the diseased ovary have resulted in an exacerbation of the symptoms. In other words, the dose administered should correspond at least to that of the temporary castration dose in order to inhibit the activity of the diseased ovary. The question of the effectiveness of mild dosage is still under test, and the opinions expressed are tentative.

In the present series, 14 of the cases received roentgen treatment alone. The remainder received operative preparation before deep irradiation. Clinical cure was obtained in 22 of the cases (19 were confirmed histologically). Distinct improvement was observed in 9 additional cases. Eight cases in the series could not be traced. Only 5 cases died, one from postoperative fistula and 4 from an acute pulmonary tuberculosis. It is believed that one of the fatalities was undoubtedly due to the treatment and probably would have been avoided if the indications had been carefully observed.

GREENOUGH, ROBERT B. The radiological treatment of cancer. *Surg., Gynec. & Obst.*, 1927, xliv (Suppl. 1), 108–115.

The evaluation of radiotherapy indicates (*a*) that destructive irradiation in certain selected situations is capable of curing metastasizing cancer; (*b*) that many precancerous conditions can be cured by non-destructive irradiation; (*c*) that deep non-destructive irradiation may retard the development of cancer and may mitigate or control distressing symptoms, but that these effects are almost invariably of a temporary rather than of a permanent character. This applies particularly to cancer involving the lymph nodes.

The best interests of the cancer patient demand that all effective methods of treatment be made available to him so that a judicious choice of a well-considered combination of methods may give to such a patient his best chance of cure, or, failing that, his best chance for a prolongation of life and a relief of symptoms.

GUISEZ, JEAN. Presentation of cases of cancer of the esophagus treated by radium therapy. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, I, 8–14.

A series of 6 case reports are given in which radium was used for treating cancer of the esophagus. The first was that of an epithelioma in a man aged sixty in which there was difficulty of deglutition; at times alimentation was entirely prevented. Biopsy showed the cancer to be an epithelioma of the cylindric cells. Six applications of radium therapy were given in quantities of 4 to 6 centigrams at two-day intervals. At the end of this time the permeability of the esophagus was greatly increased and the ulceration had practically disappeared; deglutition was almost normal. After a year, another application of radium was given; esophagoscope showed diappearance of the budding and on the surface of the esophagus scar tissue in place of the ulceration. Examination fourteen years later showed the patient to have normal alimentation and to be in excellent health.

The second patient was seventy-two years of age, suffering from dysphagia, having suffered from the condition for fifteen years. Esophagoscopic examination showed a large ring of budding cancerous tissue; biopsy showed this to be a basal cell epithelioma. Treatments with radium for six hours on each of five days at two-day intervals resulted in normal deglu-

tition which was continued until the present time, a year after treatment.

The next patient was forty-seven years old and suffered from complete dysphagia. The affection had started four and one half months previously with progressive dysphagia, with marked emaciation. After gastrostomy the weight of the patient remained stationary. Specific treatment with medicines was without avail. Seven applications of radium at two-day intervals (except the sixth and seventh treatments which were at four-day intervals) of seven to eight hours each were applied. The dysphagia disappeared, and the deglutition of liquids became possible very shortly and there was progressive amelioration of the condition so that solids could be easily swallowed; the gastrostomy was closed a month after the first treatment. Six months later the patient had returned to work and alimentation was practically normal.

The fourth patient, aged sixty-one, suffered from a basal-cell epithelioma of the esophagus causing incomplete dysphagia. Local applications of - centigrams of radium for five to six hours on each of six days at two-day intervals brought about rapid amelioration and complete cure.

The other 2 cases showed somewhat the same conditions, basal-cell epithelioma, and treatment with radium was successful in bringing about complete cure.

Heidenhain, Lothar. Roentgen treatment and inflammation. *Strahlentherapie*, 1926, xxiv, 37–51.

This is a review of the clinical aspects of the treatment with roentgen rays of acute and subacute inflammations. The treatment of tuberculosis discloses many of the general features of the effects of irradiation. Experience has shown that it is advisable to await the full development of the effects of irradiation before a new exposure is given. When extremely small doses of roentgen rays are used, the effects produced are very similar to those caused by sunlight. The progress, however, as is well known is slow.

On the other hand, in the treatment of acute inflammations the rapidity of the effect is much more striking and rapid. In this group also, improvement in the general condition precedes cure of the local process. A consideration of the effects leads to the conclusion that general and local effects of the irradiation go hand in hand in acute diseases and are so intertwined as to be hardly separable. It is well known that the most favorable effects are obtained in the early cases, and demonstrable pus formation always demands drainage before irradiation. It is hardly possible for an acute abscess to be resorbed after irradiation. General surgical principles must govern the treatment.

A tabular review shows the results of the treatment of 855 cases of acute inflammations of various kinds; 649, or 76 per cent, showed quick and smooth recovery without subsequent surgical treatment, or those with somewhat retarded cures and developing an abscess demanding drainage. There were 162, or 19 per cent, of the cases in which the result of radiation treatment was doubtful or ineffective. There were 46 cases (5 per cent) on whom no report could be obtained. Experience leads the author to emphasize that acute osteomyelitis in early cases is not improved by radiation treatment. Radical operation and drainage seems to give the only hope. In the treatment of sepsis, experience shows that irradiation of a cryptogenetic sepsis will not cause improvement, and this applies also to a sepsis originating from a definite point and existing for some time. On the other hand, early attack has yielded striking results in cases of bacterial sepsis of the blood in which it was possible to attack the focal point with the rays.

The lower limit of dosage does not seem yet to have fallen below the threshold of effective response. On the other hand, the upper limit determined by experience should not be exceeded. The author has operated his apparatus at 140 kv. maximum, with the rays filtered through 0.5 mm. Zn plus 0.5 mm. Al. The customary dose in R units lay between 50 and 160, the maximum 200 R; in Holzknecht units the dose was between 1 and 3 H.

Herrnheiser, Gustav. Roentgen therapy of tendovaginitis crepitans. *Acta radiol.*, 1926, vi, 545–556.

Acute tendovaginitis crepitans seems to be favorably affected by roentgen irradiation with small doses. This method of treatment offers the advantage of being not only simple and entirely free from danger, but also that it does not inconvenience the patient, while at the same time effecting a cure in the same time (or possibly less) as the usual fixation treatment. The radiation treatment is especially to be recommended if the patient wishes to work *moderately* with the injured limb during the period of treatment, if pain and crepitation are to be eliminated as quickly as possible, and if the application of a fixation is rendered difficult for external reasons. In cases of chronic tendovaginitis, the effects of radiation treatment are less striking and many cases remain refractory.

The author believes that the effects of the

irradiation of the inflammation may be partly due to a mechanical component as well as to the accepted immunological responses.

HEYERDAHL, S. A. On radium treatment of sarcomata in the oral cavity and the pharynx. *Acta radiol.*, 1926, vi, 557–565.

A description is given of the various types and localizations of sarcoma in the oral cavity and the results obtained by radium treatment in a number of such cases. Some of the latter were not previously operated on and in others the radium treatment was applied after surgical extirpation of the tumor. According to the author's experience, the best results are obtained from the radium treatment in cases of lymphosarcoma by the direct insertion of radioactive needles into the tumor of the tonsil, together with the external application of radium on glandular metastases.

Mention is also made of the relatively benign giant cell sarcomas of the gums and the endotheliomas of the hard palate. These tumors disappear after radium treatment and do not seem to have any tendency to recur after the treatment. Five illustrative cases are cited.

HEYMAN, JAMES. Our experience at Radiumhemmet with radiological treatment of cancer of the corpus uteri. *Acta radiol.*, 1926, vi, 566–576.

The period dealt with in this report covers the ten years, 1913–1922. The number of cases treated was 91; of these 69 received primary radiological treatment, 4 radiological treatment after incomplete operation, 10 recurrences, 8 prophylactic treatments after operation. Of the 69 primarily treated, 42 per cent were inoperable, 36.2 per cent were technically operable and 21.7 per cent were operable. The results were as follows: Of those receiving primary treatment, 54.5 per cent of all the cases between 1913 and 1919 were free from symptoms after five years. Of all the inoperable cases from 1916 to 1919, 44.4 per cent were free from symptoms after five years; from 1916 to 1922, 37.9 per cent were free from symptoms after two years. Of the operable and technically operable cases treated from 1913 to 1919, 61.5 per cent were free from symptoms after five years. Of the recurrences treated for the ten-year period, 60 per cent were free from symptoms after three to ten years. In the group of prophylactically treated cases 75 per cent remained free from symptoms for two to nine years.

The majority of cases received combined roentgen and radium treatment, the technique varying considerably during the past years. At the present time, the roentgen dose consists of three treatments of one-third skin erythema dose over each of two abdominal fields and one back field during the course of nine to ten days. The intra-uterine dose of radium has been the same as that employed in cancer of the cervix. The vaginal dose has been restricted, as a rule, to two-thirds of that customary in cancer of the cervix. No serious rectal injuries or relapses in the vagina have been encountered.

The results obtained in this limited series seem to indicate that with operable cases radiological treatment is a justifiable method and possibly of the same value as surgical treatment. Technically troublesome and inoperable cases ought to be treated radiologically. Furthermore, relapses can be treated to advantage by the radiological method.

HOLFELDER, H. What fundamentals of modern deep therapy should also be considered in the treatment of so-called internal diseases? *Acta radiol.*, 1926, vi, 583–596.

It is shown that the essence of modern deep therapy does not consist in the use of the strongest doses, but is based on the most careful consideration for the overlying and neighboring connective tissue, that is, on the greatest possible avoidance of collateral injuries and undesired after-affects. Roentgen therapy in internal medicine is in the same degree deep therapy as the roentgen therapy of malignant tumors. The principle of single dosage is not applicable to roentgen therapy in internal medicine, nor is the aim of spatial homogeneity of the effective dose upon the site of the disease, especially on a physiologically important, reactive organ.

On the other hand, roentgen therapy in internal medicine has by no means turned to full account the advantages which are involved in the three important principles, namely, (1) the most delicate possible treatment of the skin and of the layers of the body covering the focus of disease; (2) the most delicate possible treatment of all the parts and organs of the body which are not directly attacked, and especially maximum limitation of the part of the body irradiated, and (3) the systematic time apportionment of the roentgen dose with due attention to the degree of reaction still remaining from the preceding irradiation as well as from the treatment being administered.

HOLZKNECHT, G. Roentgen treatment of spontaneous post-traumatic and postoperative coccus inflammations and suppurations. *Acta radiol.*, 1926, vi, 607–614.

The author confirms the findings of others—the fact that in cases of acute and subacute

infections of all regions, the timely and correct application of roentgen rays on the focus has a surprising action in causing a favorable turn of the infection in a majority of cases.

Several hundred cases have been studied. In the beginning, satisfactory results were obtained in only a small percentage of the cases. With present developments in the technique, about two-thirds of the cases of phlegmons and abscesses of the extremities, of the trunk, of the throat and face, also of periproctitis, parametritis, postoperative pneumonia, etc., are considered favorably affected by the roentgen treatment. Half of the favorably affected group recover by quick lysis and the other half by crisis or by abortion of the infection. The remainder of the cases studied, including infections of the accessory cavities of the nose, and also cases in all other regions, have shown no marked response for reasons unknown.

The technique is sometimes that of roentgen therapy alone, and sometimes combined with surgical treatment. As early as possible, the infected focus and its surroundings is irradiated once with rays of medium penetration through 0.5 mm. heavy metal filter, the field receiving a superficial dose of about 20 per cent of the skin erythema dose (2 H). Under very severe conditions, 1 H, and in children, $\frac{1}{2}$ to $\frac{3}{4}$ H is administered. The depth dose is not taken into consideration. After the lapse of four to six days, if the result is incomplete, a second and, if necessary, a subsequent third similar dose is applied. Curiously, greater doses usually have no effect.

In the favorable 60 per cent of the cases the condition may or may not become temporarily aggravated after treatment, but temperature, pain and swelling disappear quickly in twenty-four hours, or by lysis in a few days, either without leaving any trace or there is formed one or more fusions of pus which seldom perforate spontaneously but must be opened by incision or puncture. Otherwise the process may again become inflamed. The author quotes Heidenhain's dicta: "Do not open before irradiation." "Wait and do not become alarmed by anything, even by lymphangitis."

Serologically, the radiation treatment is followed for four to six days by a rise of the bacteriolytic power of the blood. Sterile pus, usually a rare occurrence, is frequent after radiation therapy.

The explanation of the effect differs. According to Pordes, it is due to injury to the highly susceptible leucocytes of the infiltration, with liberation of the antitoxins and bacteriolysins contained in them in consequence of constitutional, pathological causes.

LAIGNEL-LAVASTINE, and GEORGE, P. Aplastic pernicious anemia following injections of thorium X. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 1617–1621.

This is a case report of a patient thirty-seven years old suffering from grave pernicious anemia, with very distressing symptoms, which became progressively more serious and which did not respond to any treatments, even blood transfusion. The indications were that this condition was caused by the improper use of radium. Thorium, in this case, was employed by the authors as treatment of the anemia; a total of 17,700 mg. were injected. Aplastic pernicious anemia resulted either from defective preparations in the ampules, or too strong effect on the blood cells by the radioactive substance.

LEDOUX-LEBARD, R., and PIOT, E. Two cases of sarcoma of the ilium treated by penetrating roentgen therapy. *J. de radiol. et d'électrol.*, Aug., 1927, xi, 424–428.

The first case was in a man of fifty-nine in whom the roentgen examination showed an osteosarcoma of the whole right iliac bone. When treatment was begun he had been in bed for four months with intense pain in the whole right half of the pelvis; he could not sit up in bed or move the right leg spontaneously. From Dec. 17, 1924, to Jan. 9, 1925, roentgen treatment was given as follows: Constant tension Ledoux-Lebard apparatus, 200 kv., 3 ma., filtration 1 mm. copper and 0.5 mm. aluminum; focal distance 30 cm., fields 12 × 12 cm. The patient was given 20,000 R over four fields, two anterior, one lateral and one posterior. There was immediately marked improvement in the pain. He was given another series of 12,000 R in April. At the end of August he could walk on crutches and move his hip joint spontaneously. He was seen in January, 1926, a year after the first treatment and could walk with a cane without crutches. He felt only a slight heaviness in the right leg. He could stand on his right leg and walk up and down stairs. The atrophy of the muscles persisted and the large dose had caused an area of sclerodermia in the iliac region. His general health was good and remains so more than two years after the beginning of the treatment.

The second case was in a young man of twenty-three who had a tumor of the same kind in the same location; he was given a treatment of 16,000 R; the tumor disappeared, he is in excellent health and able to work. These two

tumors were alike in their site and nature and the favorable reaction to roentgen treatment.

MARTIN, J. M. X-ray therapy in skin malignancies. *Radiology*, March, 1927, viii, 204–214.

This paper purports to be an argument in favor of roentgen therapy in skin malignancies. It is recalled that roentgenotherapy was first used in the treatment of skin cancer, and with very good results, but because of under or over treatment discouraging results were obtained by many radiologists and this method has not been employed nearly as universally as it should be. Case reports and illustrations are given as proof of complete cures of skin cancers by roentgenotherapy. The author also points out excellent reasons why this therapy should be used. He reminds the reader that the roentgen ray offers prompt and reliable means of removing practically every type of precancerous condition without leaving unsightly scars; there is no mortality hazard, a fatal result has probably never resulted from such therapy; there is practically no pain nor direct suffering from this treatment; the length of time required for cure is the most objectionable feature; it is possible to prevent or control metastasis when the treatment is properly used; the possibility of recurrence of the lesion is no greater from this type of therapy than from any other. It is not possible to expect cures in every case, but the percentage is high. It is often advisable to combine the roentgenotherapy with other measures. It is, of course, best to treat cases of skin cancer in its early stages if success is to be expected.

MAYER, ERNST G. Combination of roentgen irradiation with intravenous injections of dextrose in the treatment of carcinoma. *Strablentherapie*, 1926, xxiii, 604–630.

The author has attempted to increase the sensitivity of carcinoma by first overloading it with dextrose before roentgen treatment. More or less extensive abstracts are given of the case reports in which the treatment produced any noteworthy results. Quite a number of the cases were amongst foreigners who could not be traced for further examination. The series includes a total of 84 cases, but the number is too small and the period of observation entirely too short for a final conclusion as to the value of the combined treatment. However it may be stated that the percentage of cases showing a distinct improvement in the objective finding appears to be considerably greater than among patients who have received radiation therapy alone. Another noteworthy point is the rapidity and the extent of the regression under combined treatment. The early reaction in a few cases was fairly severe. There was, however, not a single case showing signs of an increased sensitivity of the healthy tissue. Inflammatory complications, of course, occurred in a number of the cases, but the author does not believe that there was any causal connection between the inflammations and the treatment. A very striking observation of importance was the varying sensitivity of metastases of one and the same tumor. Some glands retrogressed very rapidly, while others did so much more slowly, whereas still others increased in size first and gradually became smaller after repeated irradiation.

MUIR, JOSEPH. Radio-active substances: their therapeutic uses and applications. The radium treatment of hyperthyroidism. *Radiology*, March, 1927, viii, 223–229.

This is a review of the use of radium in the treatment of hyperthyroidism. This form of therapy was used as early as 1904 by Robert Abbe and successful results have been reported for this disease since that time. For some reason this therapy did not enjoy wide popularity until after the close of the World War, but during the past five years the literature has become very prolific in this study. This paper is concerned with a discussion of the results obtained by investigators in this field in which abundant proof is given of the value of this therapy in hyperthyroidism; the percentage of cures is indeed high and the method has become firmly established. Aside from its direct therapeutic value as a treatment of the disease, the use of radium is desirable because it does not excite the patient and is devoid of the other distressing mental hazards commonly noticed when surgical procedures are employed.

PAULIAN, M. D. Cerebral tumor successfully treated by deep roentgenotherapy. *Bull. et mém Soc. méd. d. hôp. de Par.*, 1926, I, 1428–29.

A patient thirty-six years old suffering from cerebral tumor was treated with deep roentgenotherapy instead of resorting to operation, with definite and progressive amelioration of the condition. Removal of 25 c.c. of cerebrospinal fluid gave temporary relief, but after a recurrence of the symptoms, operation was indicated. As a last resort, treatment with roentgenotherapy was resorted to before operation. The roentgen-ray treatment was directed to the temporal, occipital and frontal regions.

After six weeks the condition was greatly ameliorated and the symptoms relieved.

Pfahler, G. E. The x-rays and radium in the fight against cancer. *Radiology*, March, 1927, viii, 215–222.

This is a review of the present status of the use of the roentgen ray and radium in the treatment of cancer. The author first gives the present aims in the treatment of cancer, emphasizing the importance of early diagnosis and immediate treatment with the roentgen ray or radium, radically and thoroughly. Education of the public and thoroughness on the part of the physician are important factors in early diagnosis. The use of roentgenograms is important in the early diagnosis of cancer of the esophagus, the stomach, colon and rectum, and is most important in determining the existence of tumors involving bones, the chest, liver, pancreas, brain and spinal cord. The roentgen ray and radium are of value only on those tissues which are actually penetrated by the rays; for this reason it is essential that all the cancerous tissue should be thoroughly irradiated. Although the curative changes can be followed microscopically, it is necessary still to deal with these conditions as a disease that can be seen and felt. It is still felt that a combination of excision and radiation produces the best results. When pre-operative irradiation is used, the operation should be done as soon as the constitutional effects of the radiation have passed, from two days to two weeks after irradiation. Postoperative irradiation is also accepted as advisable in that this is considered as a treatment of the remnants of cancer which cannot be seen or felt and have not been removed. This radiation should be employed as soon after the operation as practicable, usually from one to two weeks. Fractional doses are preferable to massive doses.

Cancer of the skin can be cured in almost all cases by irradiation alone or irradiation following electrocoagulation. In places where the greatest conservation of tissue is desired, such as cancer of the eyelids, radium is best. Where a soft scar is not objectionable, electrocoagulation, curetting at the base followed by irradiation gives best results. When cancer of the breast is treated early, cures may be expected by excision if the lesion is purely localized, but if it has spread to the glands of the axilla, only about 20 per cent cures may be expected. If irradiation is combined with operation, cures of 36 to 46 per cent may be expected, or about twice that from operation alone.

Radium has been used successfully in the treatment of cancer of the lip, mouth, tongue, uterus, etc., the percentage of cures being rather high. Radium in these cases is better than the roentgen ray. Cancer of the gums, cheek, tonsils and pharynx is more responsive to radium treatment than cancer of the tongue and the floor of the mouth.

Tables are given showing the results obtained with different kinds of treatment of various types of cancer as reported by well-known investigators. Early diagnosis and thorough radical treatment is the best hope in the fight against cancer.

Piergrossi, L. Unknown factors in the problem of the radiosensitiveness of cancer. *Radiol. med.*, Nov., 1927, xiv, 1012–1020.

The karyokinetic index of De Nabias and Forestier has aroused a great deal of discussion, and while it is not arithmetically exact, because of the small amount of tissue examined and the varying activity of karyokinesis in different parts of a tumor, it is probably true in a general way that the more active the proliferation in a tumor, the greater its radiosensitiveness. The author believes the law may be stated somewhat as follows: the radiosensitiveness of malignant tumors decreases in proportion to the decrease in their proliferative power until it reaches a minimum, which is the radiosensitiveness of the tissue in which it originates. So no tumor can be less radiosensitive than the tissue in which it develops, but it may be equally radiosensitive and in that case the tumor cannot be injured without injuring the tissue.

But even if the parallelism between proliferative capacity and radiosensitiveness is admitted and it is conceded that the irradiation must be prolonged until all the cells have entered upon karyokinesis, the length of the interkaryokinetic phase is still unknown and there are still some tumors that are hardly affected at all by rays and some that are cured for so long a time that the treatment may be regarded as a real cure.

Other factors that are still unknown are the optimum hardness and intensity of the radiation and duration of treatment and the exact effect of the rays not only on the epithelial cells but on the connective tissue. It is necessary to find a dosage of rays that will not injure the connective tissue and yet not stimulate it. But the fact remains that rays do cure some cases of cancer and further research offers the possibility of deeper understanding of the unknown factors still involved in their use.

Pordes, Fritz. On the roentgen treatment of inflammatory diseases. General and Special. *Strahlentherapie*, 1926, xxiv, 73–86.

General. Irradiation *in vitro* shows that the leucocytes are selectively destroyed in the inflammatory exudate. It therefore seems at least a possibility that constituents of these cells may become active as decomposition products; and this lends support to the theory that the decomposition products may be the active agents following irradiation.

Special. The inflammatory affections of the dental periosteum, as well as the conditions following such inflammations, respond very well to roentgen-ray treatment and apparently to a much better degree than other focal infections. The technique of irradiation is as follows: Small fields of exposure, minimum doses, about 2 H, corresponding to about 100 R, or 15 per cent of the skin erythema dose, measured at the surface, the rays being filtered through 3 mm. Al. Special attention should be paid to the subsequent infection after irradiation because of characteristic change in its progress, acceleration in abscess formation and the appearance of abscesses exhibiting few symptoms. The more acute the inflammation, the better the prognosis from radiation therapy. The chronic forms of periodontitis are also amenable to the treatment.

A preliminary report is given of 6 cases of ocular infections (sympathetic ophthalmia, iritis and blepharitis) treated successfully with roentgen rays.

REGAUD, CLAUDE. What is the value and what should be the organization and equipment of institutions for the treatment of cancer by radium and *x*-rays? *Surg., Gynec. & Obst.*, 1927, xliv (Suppl. II), 116–140.

The treatment of cancer tends to become centralized in special establishments. The causes of this evolution are: (1) on the one hand the necessity of associating more and more closely physicians and scientists and of substituting for the work of the individual the collective work of a staff; (2) on the other hand, the increasing part played by radiologic methods in the treatment of cancer, the specialization of apparatus designed for deep roentgen therapy, and the enormous cost of necessary quantities of radium. In such establishments a choice of methods is easily made in a spirit of impartiality. The loaning of radium or the sale of radium emanation on order by associations of doctors or commercial companies tends to maintain individual initiative in cancer treatment, but has the disadvantage of making radium therapy, which is a difficult method, available to doctors of medicine who are not altogether competent to practice it.

The creation of special establishments rendered necessary by the development of radiotherapeutic methods is justified by the results that they are already capable of accomplishing. In the various localizations of epidermal cancers, the use of roentgen rays and of radium gives results equal to those of surgery and, taken all in all, probably superior. In other forms of cancer the advance made by radiologic methods is much less; employed alone, they do not ordinarily furnish more than palliative results, although these too are important; it is often necessary to combine them with surgical intervention. Their failures are due: (1) to radioresistance of the neoplasm; (2) to the great (local) extension—two limitations which will be overcome by new advances in the fields of biology and technique, and (3) to the generalization of the disease—an obstacle which seems insurmountable for radiotherapy.

The progress to be expected in radiologic methods should make us regard as very useful the organization of a department of radiophysiologic research in all the great establishments of radiotherapy. It is not necessary for special establishments devoted to the treatment of cancer to be near the residence of patients. On the other hand, the complexity of their organizations and the cost of their equipment do not permit the erection of many of them. These two reasons combine to restrict their number. In the treatment of cancer every other consideration must be subordinated to the perfection of treatment, since radiotherapy, like surgical treatment, cannot be repeated. As regards the morale of the patients, it is desirable that the word "cancer" should not be written into the title of a therapeutic establishment and that patients suffering with various forms of benign tumors curable by radiation should be admitted along with cancer patients. The organization of establishments designed to treat cancer includes: examination of the patient and the work necessary for diagnosis, the treatment proper, and the careful preservation of all records. Every important establishment devoted to radiotherapy of cancer must be able to provide hospital care for the patients and must not confine itself simply to the treatment of ambulant patients. A competent surgical service is equally indispensable.

The protection of the personnel from lesions caused by roentgen rays and radium must be made the object of scrupulous discipline. The careful and effective administration of roentgen rays and radium absolutely demands the actual participation of the physician at every sitting and at every dressing followed by re-application. At each sitting, particularly for deep

roentgen therapy, the placing of the patient in the field of irradiation is a duty belonging exclusively to the physician and must not be performed by the assistant who simply follows directions. The question of the superiority of radium over roentgen rays or vice versa is of great importance for the equipment of an establishment but it has not been settled from a practical point of view. Radium may be employed either in the state of a solid salt or in solution for the preparation of radium emanation. A well-equipped establishment should have both methods at its disposal because each has advantages and disadvantages. However, radium in the form of a solid salt seems at the present time to lend itself to more general use than radium emanation.

Scal, J. Coleman. Irradiation of diseased tonsils. *Med. J. & Rec.*, 1926, cxxiv, 873.

This article describes a new method of treating tonsillar hypertrophies by means of removable platinum radon seeds, giving detailed reports of a series of cases where tonsillectomy was for different reasons contraindicated, and illustrating the application of the technique to varying pathological conditions.

To carry out the application of the seeds, a new implanter is used which is illustrated and described in the article.

As the pain of implantation and removal is practically *nil*, at no time is any anesthetic required, there is no need of hospitalization, nor disability of any kind. The total absence of shock is a great advantage in inoperable cases.

By means of the implanter the operator is able to place one removable radon seed in the center of a tonsil so that radiation is distributed equally throughout. The radon seed used is filtered by 0.3 mm. of platinum. This filtration cuts off the beta rays, thus doing away with all possibility of burning with consequent necrosis and sloughing.

When the instrument is withdrawn after implantation the seed is left imbedded in the tonsil with a 2 cm. length of thread protruding from the portal of entry. This short thread does not in any way inconvenience the patient, nor cause the slightest interference with function. At the end of four days the seeds are easily removed by grasping the thread with forceps.

The point of the trocar is so fine and the seed so small that very little trauma is done to the tonsil.

The amount of radiation can be measured with accuracy and the applicators located with such exactness as to insure equal and complete distribution throughout the tissues. Only one treatment is necessary, a fact much appreciated by the patient. Systemic reactions of any kind never occur. The attached thread, making the seed easily removable when its period of service is over, does away with an objectionable foreign body being left in the tissues—a drawback to the bare tube method. The author concludes that in the implantation of removable platinum radon seeds we have at present an adequate substitute for tonsillectomy in those cases where surgery is, for any reason, contraindicated.

The technique and method described have been developed by Dr. Joseph Muir of New York.

Schreiner, Bernard F., and Stenstrom, A. T. End results in 563 cases of breast cancer. *Surg., Gynec. & Obst.*, 1927, xliv, 608–612.

The majority of cases presenting themselves at the State Institute for the Study of Malignant Disease, Buffalo, N. Y., with cancer of the breast were either cases in which the condition had recurred after operation or far advanced primary cases. The statistics show definitely that results in operable cases are best obtained by radical operation followed by irradiation, although in some instances radiation alone has proved of curative value.

In 43 per cent of the cases recurrence followed complete or incomplete operation for cancer of the breast. In the prophylactic group, 19 patients died from cancer and 35 remained free from the disease from six months to eleven years.

Of 8 cases in group I (primary) treated by radiation alone, 3 patients are clinically well, 2 for five years and one for over a year. Of 9 cases in the same group treated with radiation plus radical operation, 7 have been clinically well from one to six years. Two patients in group I (recurrent postoperative) treated by radiation are clinically well, one for one year and the other for seven years. Of 32 cases in group II (primary) treated with radiation, 4 have been clinically well for from two to six years. Of the 14 patients treated with radiation and surgery, 5 have been clinically well for a period of from one to six years. There are no cases in the same group (recurrent and postoperative) that are clinically well, although 2 of the 4 treated were well for a year and then developed recurrence and died, one to three years later.

Of 51 patients in group III (primary) treated with radiation, 7 have been well for a period of from one to four years. Of the 35 patients treated with radiation and surgery,

7 have been clinically well for from one to four years. Of the 41 cases in group III (recurrent, postoperative) treated with radiation, 6 have been clinically well one to two years.

Of the 80 patients in group IV (primary) treated with radiation, 17 have been alive from one to four years after admission, of whom 3 have been clinically well but their chest plates suggest mediastinal involvement. Of the 8 patients treated with radiation and surgery, 2 are alive and have had palliation, one for two years and one for four years. Of the 168 cases in group IV (recurrent, postoperative) treated with radiation, 28 patients are alive having had palliation from less than a year up to four years. The 3 cases in group IV (recurrent, postoperative) treated with radiation and surgery have been alive and improved from one to three years.

From 1920 to 1925 the patients were treated by means of high voltage roentgen rays with varying technique as to distance and portals. During 1921, 1922 and 1923 crossfiring and massive doses were tried but resulted in much depression, roentgen sickness, and on the whole did not seem to justify the procedure. Since that time the technique has been modified to the present method which is to divide the required quantity of roentgen rays over a period of a week to twelve days allowing for the time elapsed between treatments, the desire being to administer from 120 to 150 per cent on the skin. This procedure is believed to be more beneficial; and there are fewer recurrences. The roentgen rays were at times supplemented with implantation of radium in the primary growth.

SCHWARZ, G. Radiation therapeutic sensitization by means of mustard oil. *Strahlentherapie*, 1926, xxiii, 702–705.

The object of this communication is to suggest the employment of tinctures containing mustard oil as an aid in the radiation therapy of accessible tumors such as those in the uterus, skin, breast, mouth, etc., in which a roentgen or radium application alone has been found inadequate. It is pointed out that mustard oil produces characteristic early and late skin reactions very similar to those called forth by radiations of short wave length. Typical sensitizing effects are produced by the employment of mustard plasters and even greater degrees of sensitization are obtained by the direct employment of mustard oil.

SEIDS, J. V., and MCGINNIS, R. S. Malignant tumors of fatty tissues. *Surg., Gynec. & Obst.*, 1927, xliv, 232–243.

The authors give a fairly extensive review of the literature and add observations on 5 cases of liposarcoma. Very often lipomata found in the retroperitoneal and intermuscular regions pursue a definitely malignant course, recurring as fibrolipomas or fibromyxolipomas and finally as definite liposarcomas. Occasionally subcutaneous lipomas manifest the same tendency.) The highly malignant nature of these tumors is not properly appreciated. They should be dealt with radically as in the case of other malignant neoplasms by thorough extirpation followed by roentgen irradiation.

The roentgen ray is of no avail in the advanced cases, but if used early and intensively after the initial operation it may prove beneficial. In the 5 cases described roentgen therapy after surgery proved beneficial in one case; but in 3 others the roentgen treatment was of no avail. The end-result in the favorable case still remains to be seen.

TAPARELLI, ARNALDO. A case of giant-cell tumor of the left elbow treated by roentgen rays. *Radiol. med.*, Oct., 1927, xiv, 859–868.

The author showed a case of disease of the lower end of the humerus in which he had made a diagnosis of giant-cell sarcoma in 1920 from the roentgen picture; this opinion was confirmed at a meeting of the Roentgen Society to which he submitted the roentgenograms. Although several roentgenologists and clinicians thought that surgical removal of the tumor was indicated he wished to try roentgen treatment first and began it at once. At present the movements of the elbow are limited and the distal extremity of the humerus is enlarged. The roentgen picture shows signs of the disease but the bone is calcified, the patient can use her arm and it is not painful; the appearance of the bone has not undergone any change for several years during which periodic roentgen examinations have been made.

VAN EBBENHORST TENGBERGEN, J. A new method of irradiation and new tube construction. *Acta radiol.*, 1926, vi, 363–368.

Homogeneous irradiation required by modern therapy is possible only with the hardest roentgen rays. However, for treatment of carcinoma a homogeneous soft radiation is the most desirable. This the author has sought to accomplish by a mechanical method of small field irradiation. By using lead sheets to limit the size of the field and shifting the small field progressively over the entire area a fairly homogeneous irradiation can be accomplished.

The solution of the problem, however, in the author's opinion, lies in a radical change in the structure of the roentgen tubes. The present model containing an anticathode and focus was developed to answer the needs of the roentgen diagnostician. It is pointed out, however, that for therapy such an arrangement is of no particular advantage and possesses certain distinct disadvantages. The suggestion is made that the customary target with focus in the roentgen tube be replaced, for therapeutic purposes, by a large metallic surface. This involves certain technical difficulties of construction that will have to be solved.

WAGNER, G. A. Roentgen therapy of inflammatory conditions in gynecology. *Strahlentherapie*, 1926, xxiv, 52–72.

A review of the subject from the clinical standpoint is presented. Observations seem to show that the application of small non-injurious quantities of roentgen rays to the ovaries results in the appearance of prolonged hyperemia, symptoms of vagal stimulation, prolonged and significant increase in the basal metabolism, all of which are regarded as signs of increased function of the gland resulting from the irradiation. It also seems that these effects may not be entirely insignificant in the general recovery process.

The indication for therapy by mild doses of roentgen rays in gynecological conditions appears primarily in those cases where conservative treatment of the inflammation is demanded. The technique in dosage depends on whether it is intended to produce permanent or temporary castration; or if it is intended to attack the inflammatory focus and at the same time avoid producing an amenorrhea. In the latter event, the technique and dosage depend largely on the localization, the extent of the process, the general condition and the age of the patient. The average dose for temporary castration corresponds to 28 to 30 per cent of the skin erythema dose. The dosage delivered by the author's apparatus at the German clinic in Prague was operated at 180 to 220 kv. peak, 3 ma., 45.5 cm. parallel spark gap, filtration through 0.5 mm. Zn plus 1 or 0.5 mm. Al, average focal skin distance 30 cm., field size 12 × 16 cm. The duration of irradiation was usually six to ten minutes; the dose applied, calculated at the skin, corresponded to 150 to 200 R, somewhat above the figure given by Heidenhain. In a few cases, a larger dose was cautiously applied. In the majority of cases a single irradiation seemed to suffice, but often two or three and rarely more treatments were needed. The intervals between treatments were about ten days, but often they were as long as several weeks or months.

The treatment must be applied with special care in cases of diffuse peritonitis. The author's experience extends to more than 350 cases, of which 216 were followed up, 122 having finished treatment one year or more. The important primary effect is the rapid cessation of pain as the result of irradiation. About 75 per cent of the cases appear to have shown a satisfactory response to the radiation treatment, and in 50 per cent of the total the result may be regarded as very good. The end-result was influenced considerably by the localization of the process, the stage of the inflammation and finally its etiology. The best results yielding 100 per cent cures occurred in the pure puerperal type of parametritis. Gonorrheal infections also responded very satisfactorily. The failures and unsatisfactory results in general occurred mostly amongst the older patients. Complete failures were found to the extent of 8 per cent of the cases in inflammations of the upper genital tract, and in 10 per cent of all the cases, there was noted a decided, although usually temporary, exacerbation of symptoms even by the application of extremely small doses.

WERNER, R. The results of a radiochemical treatment of inoperable malignant tumors in man. *Strahlentherapie*, 1926, xxiv, 153–160.

The author employed a combination of roentgen or radium therapy with concurrent injections of cholin. Most of the cases received radiations of medium hardness corresponding to two-thirds up to three-fourths of the skin erythema unit over small fields by the crossfire method. The cholin was applied in intravenous injections of 2 c.c. of 10 per cent cholin-boric acid solution (enzytol) diluted to 20 c.c. with physiological saline. The mixture was subsequently increased to 5 c.c. of enzytol diluted with 15 c.c. of saline. As a rule, twenty daily injections were given in a series, and the roentgen treatment was extended over three to four weeks. The treatment consisted, therefore, of extremely mild radiation therapy extending over a fairly long period with the roentgen rays administered concentrically about the neoplasm, this radiation treatment being combined with the chemotherapy described. The treatment was repeated two or three times, in rare cases four times, with intervening pauses of four to six weeks. A large number of the patients showed distinct improvement in the local condition in a very short time. Attempts to increase the roentgen dose or the dose of cholin resulted unsatisfactorily. A total of 741 patients received the treatment and of these, 405 could

be traced. The number of cases still alive three years after treatment was 104; those still alive five years after the treatment numbered 62. There were 26 still alive ten years after treatment. Further details as to the conditions are, however, not known. Except for 4 cases of mammary carcinoma, all the rest of the patients, without exception, were suffering from primary inoperable carcinoma or sarcoma or acute recurrences following previous operation. The great majority of the cases were regarded as hopeless before treatment.

WYETH, GEORGE A. Newer developments of electrothermic methods in the treatment of neoplasms. *Surg., Gynec. & Obst.*, 1927, xliv, 95–100.

A neoplastic growth is never of negligible importance and if possible such a lesion in its early stages should not be subjected to treatment by physical methods which might tend to lock up the malignant cells in fibrotic tissue. The malignancy should be destroyed and removed. A case is described in which a melanoma was removed with the monopolar, dehydrating current. Complete anesthesia was employed in order to avoid the traumatism of a novocain needle near the growth. The lesion was removed in a single treatment and the result was satisfactory in the highest degree.

For the removal of precancerous growths, the modern high frequency endotherm knife is very satisfactory. As produced by the three-element vacuum tube system the true cutting current causes a molecular dissolution of the tissues. With the ordinary steel needle which is the usual active electrode and which needs to be only lightly brought into contact with the skin, a clean-cut incision is made with a narrow line of coagulation on either side. This narrow line of coagulation is sufficient to seal off lymphatics and to cap sensory nerves. The incision permits of primary union with a superior cosmetic result. The technique is illustrated in the description of a case of fibroangioma in a child aged five. Another case is cited in which a large carebelliorm melanoma of the scalp was effectively removed by the endotherm knife. Details are also given of a fourth case in which an adamantinoma was successfully removed by the endotherm knife.

The advantages of this extension of surgery are the applicability to a much wider range of cases; the reduction of the danger of metastasis and the likelihood of recurrence; the quickness and ease of application; the possibility of repeated operation; the absence of surgical shock, and a minimum of hemorrhage and trauma, with soft, pliable scar.

MISCELLANEOUS

BRANDES, KONRAD. Clinical and experimental results of the studies of tumors caused by irradiation. A review. *Strahlentherapie*, 1926, xxiii, 715–772.

The author presents a bibliographic review covering some 250 references on the subject of tumor production by various parasitic, mechanical, actinic and chemical irritants. The scope is indicated by the subject headings: 1. Animal parasites, bacteria and tumor filtrates as etiological factors in tumor formation. 2. Tumor formation by mechanical, chronic inflammatory, physical and chemical irritants.

It is pointed out, in conclusion, that the irritating agent alone is not always able to produce carcinoma. Other factors are involved which may either favor the formation of tumor or prevent it; and these factors still remain insufficiently understood. The results of numerous experiments appear to contradict each other. Many theories have been set up as to the important cause of the cellular change, but none of them have as yet been generally accepted as valid. Experimental research on the effects of irritants has revealed many important facts but has not yet solved the cancer problem. The literature references are conveniently separated under subject headings.

BROMEIS, HEINZ. Urobilinogen excretion in the urine after roentgen therapy and roentgenoscopy. *Strahlentherapie*, 1926, xxiii, 687–701.

The urobilinogen reaction in the urine was found to be positive after roentgen therapy in 74 per cent of cases and after roentgenoscopy in 69 per cent of cases. So far as the trunk is concerned, the region exposed to roentgen rays is of only slight effect on urinary urobilinogen excretion. The briefest roentgenoscopic exposures appear to be sufficient to cause urinary excretion of urobilinogen. An examination of the subject indicates that the effect may be interpreted as due to an injury to the liver, possibly by toxic decomposition products, one of the end-results being elimination of urobilinogen.